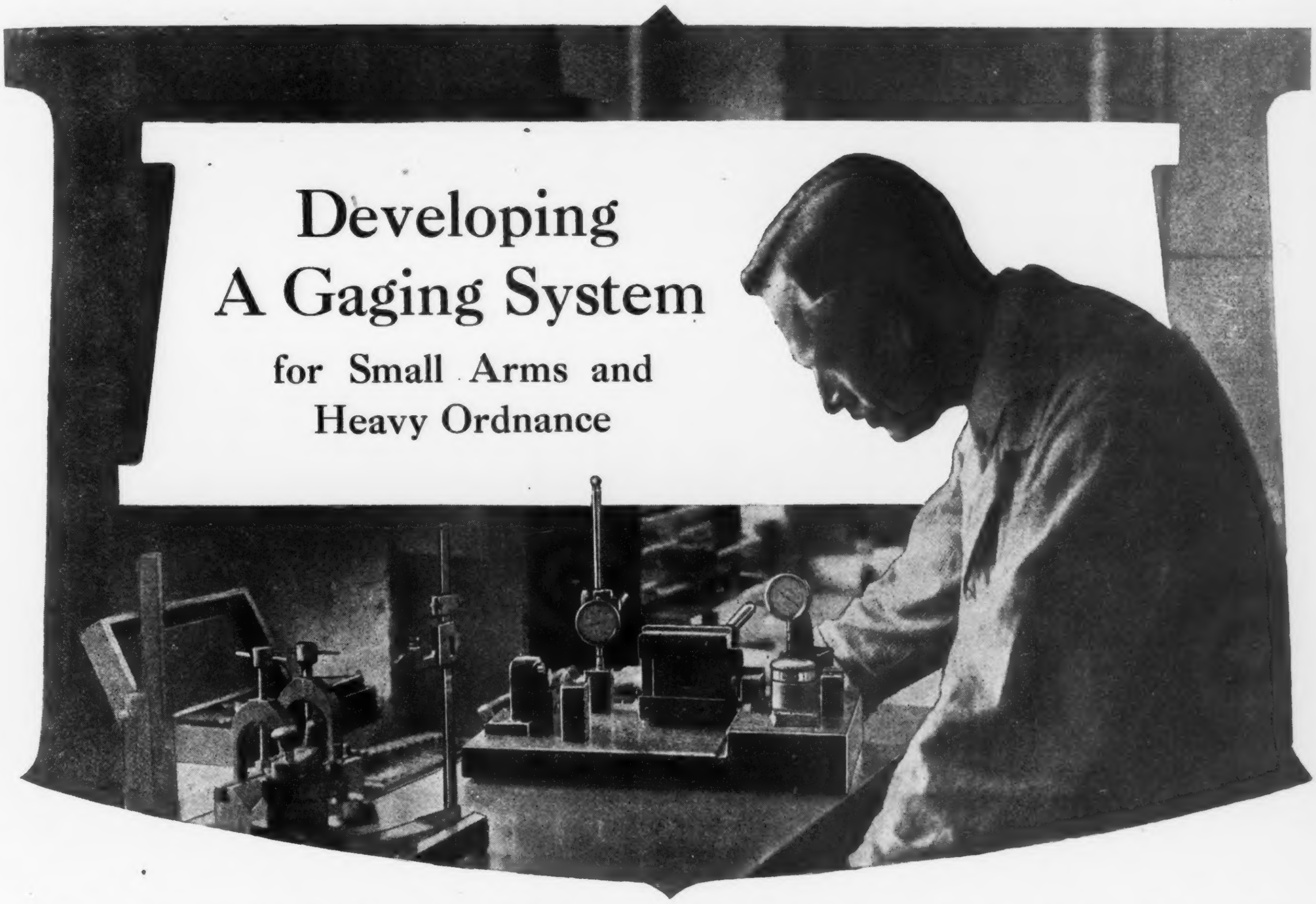
MACHINERY

THE INDUSTRIAL PRESS, Publishers, 140-148 LAFAYETTE ST., NEW YORK

OCTOBER 1918 Volume 25 Number 2



Developing A Gaging System for Small Arms and Heavy Ordnance

First of a Series of Articles Describing Principles Involved and Procedure Followed in Developing Gaging Systems for Interchangeable Manufacture—Based upon Experience of Pratt & Whitney Co. in Furnishing Gaging Equipment for Small Arms and Heavy Ordnance Work

By ERIK OBERG, Editor of MACHINERY

WHEN a part for a machine or device is made, it must be measured to ascertain that it is of the right dimensions for fulfilling the purpose for which it is intended; this applies equally whether a single piece is made, as when making a special machine, or whether a hundred-thousand pieces are made, as in interchangeable manufacturing. The simplest method of measuring a part made for a specific purpose is to fit it to the component part which it is to engage when in use. This was a common practice of measuring or gaging in the early development of the machine trade and is still used to a large extent in repair work; but, in manufacturing work, this method has been gradually displaced with the introduction of interchangeable manufacturing. The next step was to measure the part being made by various measuring devices—first a scale, and later micrometers and protractors, but often the fitting of each piece to its component part was still required in the assembling of the mechanism. Still later, as interchangeable manufacturing became more highly developed, gages were devised, making it possible, in most cases, to so accurately determine the dimensions of each individual piece that, after the parts were made, they could be assembled without further fitting.

The manufacture of small arms, heavy ordnance, and munitions of war in general has emphasized the importance of gaging systems and the adoption of suitable tolerances in a more forceful manner than has ever been the case in the manufacture of machines and mechanisms used in peaceful pursuits. It is probable that the Pratt & Whitney Co., Hartford, Conn., has done a greater pioneer work along these lines during the past few years than any other concern, and the record of the experience gained by this firm in the making of complete manufacturing and gaging equipment for rifle and heavy ordnance manufacture for the United States, Great Britain, Australia, Russia, Spain, Servia, and China, as here published for the first time, will prove a valuable addition to the technical literature of the present day.

Principal Groups of Measuring Devices

There are two broad groups of measuring tools. In one of these the dimensions measured are read off on a scale, and measuring instruments of this type may be used for measuring any distances within a certain range. The other group of measuring devices is used only for determining if a certain dimension on a piece of work is equal to a given predetermined dimension. The ordinary machinists' scale, the vernier caliper, the micrometer, protractors and measuring machines belong to the first group, while fixed gages constitute the second group. A gage may be defined, in general, as a measuring device made or set to measure one or more certain dimensions, and it is used for determining if manufactured parts have been made to agree with this dimension. If the gage is

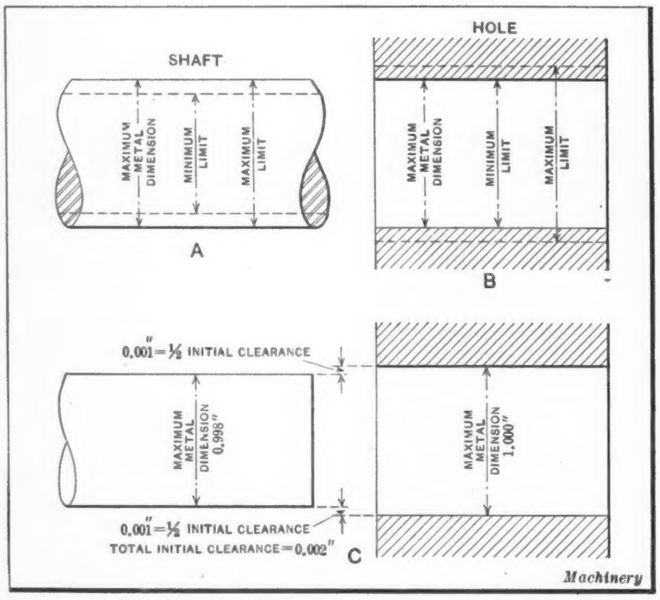


Fig. 1. Illustration showing Meaning of Some of the Terms used in Connection with Limit System of dimensioning Drawings

provided with means for measuring the maximum and the minimum dimensions to which a given piece may be made and yet fulfill the function for which it is intended, it is known as a "limit gage" (sometimes also as a "tolerance gage"), because it is the means of determining if the part is made within the predetermined limits set for it.

Gaging and Interchangeable Manufacturing

Generally speaking, therefore, gages are instruments to be used as fixed measuring devices, and consequently each gage, in general, can be applied for a certain purpose only; hence, gages are used only in interchangeable manufacture; that is, in cases where a number of similar parts are to be made, all of which may be measured by the same gage and the accuracy of which, within the prescribed limits, may thereby be assured. Gaging systems and interchangeable manufacturing are so closely tied together that it would be impossible to discuss one without also dealing with the other. The main object in the introduction of interchangeable manufacturing was to reduce costs by standardizing the manufacturing operations and reducing the time required in the assembling of a mechanism. A secondary advantage was thereby gained, however; that of a complete interchange of parts in the manufactured article. Indeed, in many instances, this last advantage has become an object equally important with the reduction of the cost in the assembling, and is insisted upon in the manufacture of rifles and heavy ordnance, so that damaged parts may be replaced with other parts without fitting. As an example of the reduction of cost in assembling, due to the adoption of an adequate gaging system, it may be mentioned that in one case the cost of assembling a rifle was $2.50. This was reduced to 25 cents by the adoption of a new tool and gage equipment, and resulted in the scrapping of the former tool and gage equipment valued at $80,000.

As an example of one of the most complete systems of gaging that have been worked out may be mentioned that for the manufacture of modern rifles. A modern rifle has from 60 to 125 parts, according to its design, and requires about 700 machining operations for its completion. For this work, not less than 1750 working gages are required. An equal number of inspection gages are used, and for every inspection gage there is one reference gage, so that altogether there are, in one set, 5250 gages.

How Far Should Interchangeability be Carried?

Interchangeability is sometimes carried too far. Where the object sought is merely to facilitate assembling, any further refinement to insure absolute interchangeability involves useless expense. Very few mechanisms, in fact, are absolutely interchangeable. Even in rifle manufacture there are a few parts where matching of the parts is permissible, this practice being known as "selective assembling." It is, therefore, necessary that proper judgment be used in determining upon the importance of interchangeability, and that the various factors be carefully weighed against each other. If it is cheaper to throw away the whole or a group of the mechanism and obtain a new one, rather than to unduly increase the expense of manufacture by aiming at the high degree of accuracy that is required for absolute interchangeability, then the refinement required for such interchangeability is unwarranted. As an example of work where interchangeable manufacturing methods are employed largely for the sake of assembling may be mentioned the case of shell or projectile work, where many of the parts are made interchangeable simply in order to facilitate assembling, because, when once assembled, they will not be again interchanged with other parts. Sometimes one part is made in one shop and other parts in another shop, in which case accuracy of dimensions is necessary in order that these parts later may be properly assembled without additional cost in fitting the parts together.

Interchangeability between Parts Made in Different Shops

The great difficulty of obtaining absolute interchangeability between products made in two different shops is due to the fact that if the two shops work entirely independently, they are likely to use different locating points, different tooling equipment, different machining methods, and different gages and gaging methods. To insure interchangeability, therefore, there must be some kind of cooperation, so that similar methods are used in the two plants.

It has been found very difficult to obtain properly interchangeable work when two plants produce the same mechanism, unless proper precautions are taken at the outset to insure interchangeability. When two plants are to manufacture the same mechanism, the most certain method of insuring interchangeability is to make sure that the locating and gaging points employed in the machining of the parts in both plants are the same. The details of the machining methods and, to some extent, the tools may vary, but the locating points and the gages ought to be identical; otherwise it is almost certain that the parts will not exactly interchange.

The modern gaging system using fixed caliper gages is said to have been introduced into the United States by John Richards, who inaugurated this system in the plant of the present John M. Rogers Works, Gloucester City, N. J., in 1865. As the methods of interchangeable manufacturing developed, these gages, instead of having one fixed dimension, were provided with means for measuring two dimensions, the maximum and the minimum measurements between which the work must come. This was the origin of the modern limit gage in use today.

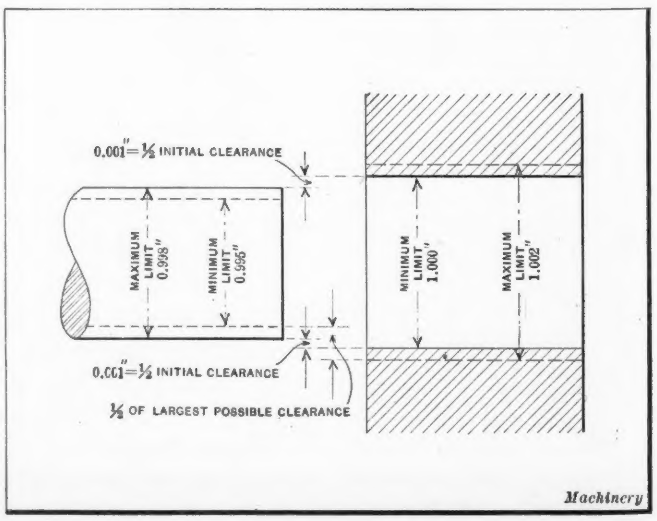


Fig. 2. Illustration indicating Meaning of Initial Clearance

Definitions of Terms Used in Gaging and Interchangeable Manufacturing

Much confusion is caused by a misunderstanding of the terms used in connection with gaging and interchangeable manufacturing, and often disputes and disagreements occur simply because terms are differently interpreted by different men. The terms that will be employed in the following will, therefore, be defined at the outset, so as to prevent any possible misunderstanding. These terms are "tolerance," "limit," "maximum metal dimension," "clearance," and "initial clearance."

Tolerance—Tolerance is the permissible variation in a given dimension of a part. For example, if it is permissible to make a part with a diameter anywhere between 0.996 inch and 1.000 inch, then the tolerance is 0.004 inch.

Limit—The limits are the maximum and minimum dimensions of a piece. For example, when the tolerance is 0.004 inch, as in the case referred to above, the maximum limit is 1.000 inch and the minimum limit is 0.996 inch.

Maximum Metal Dimension—The maximum metal dimension is the dimension which is equal to the limit at which the part contains the most amount of metal; hence, in the case of a shaft, the maximum metal dimension is the maximum limit; in the case of a hole, however, the maximum metal dimension is the minimum limit, as there is more metal in the part the smaller the hole; to enlarge the hole, of course, metal has to be removed. (See *A* and *B*, Fig. 1.) In the case of shafts and holes, it is very simple to determine which is the maximum metal dimension, but there are cases where it is somewhat difficult to say definitely which is the maximum metal dimension unless the conditions are carefully analyzed.

Clearance—Clearance is the difference in dimensions between two component parts which are assembled together, and is provided either to prevent interference, to produce a certain fit, or to provide for lubrication.

Initial Clearance—Initial clearance is the difference between the maximum metal dimensions of two component parts that are assembled together. If, for example, as at *C* in Fig. 1, the maximum metal dimension of the hole is 1.000 inch and of the shaft 0.998 inch, then the initial clearance is 0.002 inch. In Fig. 2, the tolerance for the shaft is 0.003 inch, and for the hole 0.002 inch, which makes the limits for the shaft 0.995 inch and 0.998 inch, and the limits for the hole 1.000 inch and 1.002 inch. By studying these figures in combination with the drawing, it will be seen that while the initial clearance is only 0.002 inch, the actual clearance between the two parts, if the shaft should happen to be made to the minimum limit and the hole to the maximum limit, might be 1.002 — 0.995 = 0.007 inch.

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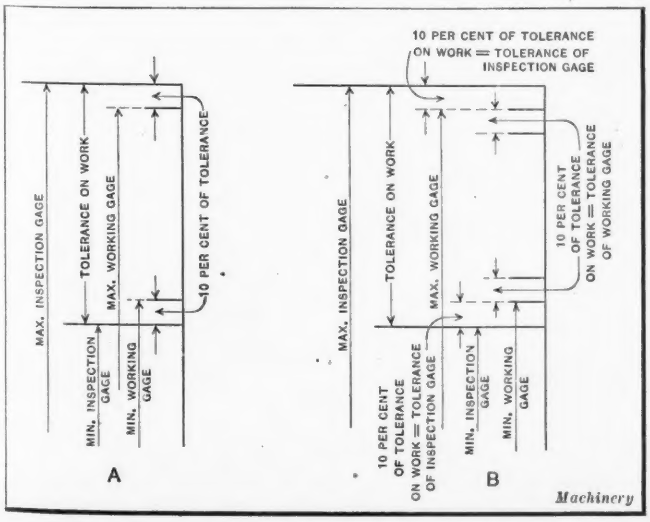


Fig. 3. Diagrammatic Illustration showing Differences between Working and Inspection Gages, and Tolerances on these Gages

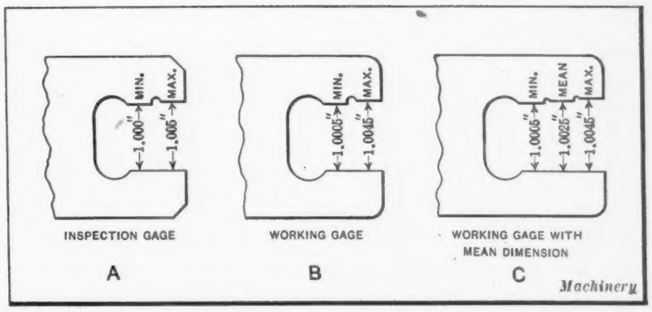


Fig. 4. Difference between Inspection and Working Snap Gages

From this it is clear that the initial clearance is equal to the difference between the maximum metal dimensions, while the total clearance may include, in addition, the tolerances, so as to become the difference between the minimum metal dimensions of both pieces.

There are a number of other terms that are frequently used that relate to the same dimensions as those defined above, such as "working tolerance," "permissible tolerance," "necessary tolerance," "high limit," "low limit," "working clearance," "allowance," and "working allowance." The use of these terms tends to produce confusion and should, therefore, be discouraged. The expression "a limit of 0.001 inch" is also objectionable and should not be employed. It is incorrect, because tolerance is meant instead of limit; and it is indefinite in that it gives no indication of whether a tolerance above or below standard size is meant. The expression may mean a tolerance of 0.001 inch above standard size; it may also mean 0.001 inch below standard size; and it might possibly mean either a tolerance of 0.0005 or 0.001 inch above and below standard size. The most important thing with regard to the expressions defined and their use is to employ them only when they mean actually the dimension for which they are used, and express definitely, without any doubt, the meaning that is to be conveyed.

Classification of Gages According to Their Use

With regard to the use to which gages are put in the shop and inspection rooms, three different kinds of gages are used—working gages, inspection gages, and reference gages, the latter also known as "check gages." As the name implies, the working gages are used by the workmen at the bench or machine in gaging the work as it is being made. The inspection gages are, of course, used by the inspectors in checking the product to determine if it has been properly made to the required dimensions. The reference gages are used for testing or checking the inspection gages from time to time, to make sure that they have not become unsuitable, through wear or otherwise, for the use for which they are intended.

Inspection Gages

The inspection gages are usually made with minimum and maximum limits, corresponding to the limits given on the drawing of the piece for which they are used. While in the making of small arms there are usually inspection gages for inspecting the work after every operation, such detailed inspection is not generally employed in interchangeable manufacture. As a rule, in the making of small parts, it is not common practice to inspect after every operation, but only at certain points during the process of manufacture; as, for example, when the parts leave one department to pass into another, or before a locating or working point on the piece being made is removed. Generally, therefore, the inspection gages are

Description of Inspection Gages	Description of Reference Gages	Remarks
1 Dial Gage	1 Ref., Dial Reading Zero	Tolerance, —0.005
1 Flush Gage	1 Ref., High Step	Tolerance, 0.008
1 Swing Gage	1 Ref., Go Step	Tolerance, 0.003

Machinery

Fig. 5. Method of giving Information relating to Tolerances on Gage Lists

fewer in number than the working gages, as this facilitates rapid inspection, is generally sufficient for a satisfactory check, and lowers the cost of the product by decreasing the cost of gages and of inspection. Sometimes one of the inspection gages may contain the gaging sizes of several working gages; in which case it is preferable, if possible, to have them so made that they could be applied after each operation in instances when this becomes desirable.

Tolerances in the Gages Themselves

By having the maximum and minimum limits of the work duplicated in the gage, it becomes possible to determine quickly and accurately if the work is made within predetermined limits. It is evident, of course, that the gage dimensions themselves can be accurate only within certain limits, as it would not be practicable to make gages for interchangeable manufacturing that would be absolutely to the required dimensions. The general practice, therefore, is to make sure that the maximum size of the gage is not larger than the maximum limit on the work and that the minimum size of the gage is not smaller than the minimum limit, and, furthermore, that the errors from these dimensions do not exceed, as a rule, 0.0002 inch. This applies to ordinary inspection gages of various types, for interchangeable manufacture, but, of course, it does not apply to so-called "standard" master plug and ring gages which are supposed to be accurate within less than 0.00005 inch, the object of these gages being to provide an actual standard of measurement for setting micrometers, originating dimensions, etc. There is, however, no definite standard with regard to the tolerance that may be permitted on the working and inspection gages used in interchangeable manufacture, as these tolerances will naturally depend, to some extent, upon the conditions, and upon the amount of tolerance in the work itself. For example, if the tolerance in the work is 0.010 inch, it is evident that the gage need not be made as accurate as when the tolerance is only 0.001 inch.

Generally, a tolerance on the gages amounting to 10 per cent of the tolerance on the work is allowable. For example, if the tolerance on the work is 0.004 inch, the tolerance on the maximum gage would be 0.0004 inch, and an equal amount on the minimum gage. As will be explained in a following paragraph, working gages are made 10 per cent of the tolerance inside of the inspection gage and drawing dimensions; hence, a tolerance of 10 per cent on the inspection gage would bring the minimum permissible dimension of the maximum limit gage down to the same size as the maximum dimension of the working gage, which is permissible. The working gage, in turn, would have a similar tolerance, but, of course, the tolerance would have to be in a direction that would not overlap the tolerance in the inspection gage. This condition is illustrated graphically at *B* in Fig. 3.

Locating pins on working and inspection gages should be made at least 0.0002 inch smaller than the minimum size of the hole in the component part for which the gage is used. In the case of reference gages, however, this is not required, as here the locating pins may be made to fit the corresponding working and inspection gages as closely as possible.

Working Gages

In the case of interchangeable manufacture, working gages should be provided for every operation, and each operator should have his own working gage. These working gages are usually limit gages provided with the maximum and the minimum gage sizes, and, when practicable, as in the case of a snap gage, also with the mean dimension. It is believed by many that, by having the mean dimension in the gage in addition to the maximum and minimum dimensions, it is easier for the workman to keep within the required limits, as he will try to work to the mean dimension, and in that way be certain to adhere to the predetermined tolerance. In the case of a snap gage, for example, having the mean dimension, there will be three steps on the gage, as indicated at *C* in Fig. 4. The mean dimension in the working gage is particularly useful when the part is machined by adjustable tools or by methods where the workman can make independent adjustments, as in that case it is claimed that, by setting the tools to the mean dimension, there is less likelihood of the piece not being between the maximum and minimum dimensions than would be the case if there were no mean dimension to which the tools could be set; in fact, it is only for conditions of this kind that the mean dimension is of any real value in a gage. If the tool were a solid reamer, for example, it is evident that the mean step on the gage would be of no value. The mean size is always omitted on inspection and reference gages.

The working gages are not made to the limits indicated on the drawing or to the size to which the inspection gages are made, but the minimum size of the working gage is made

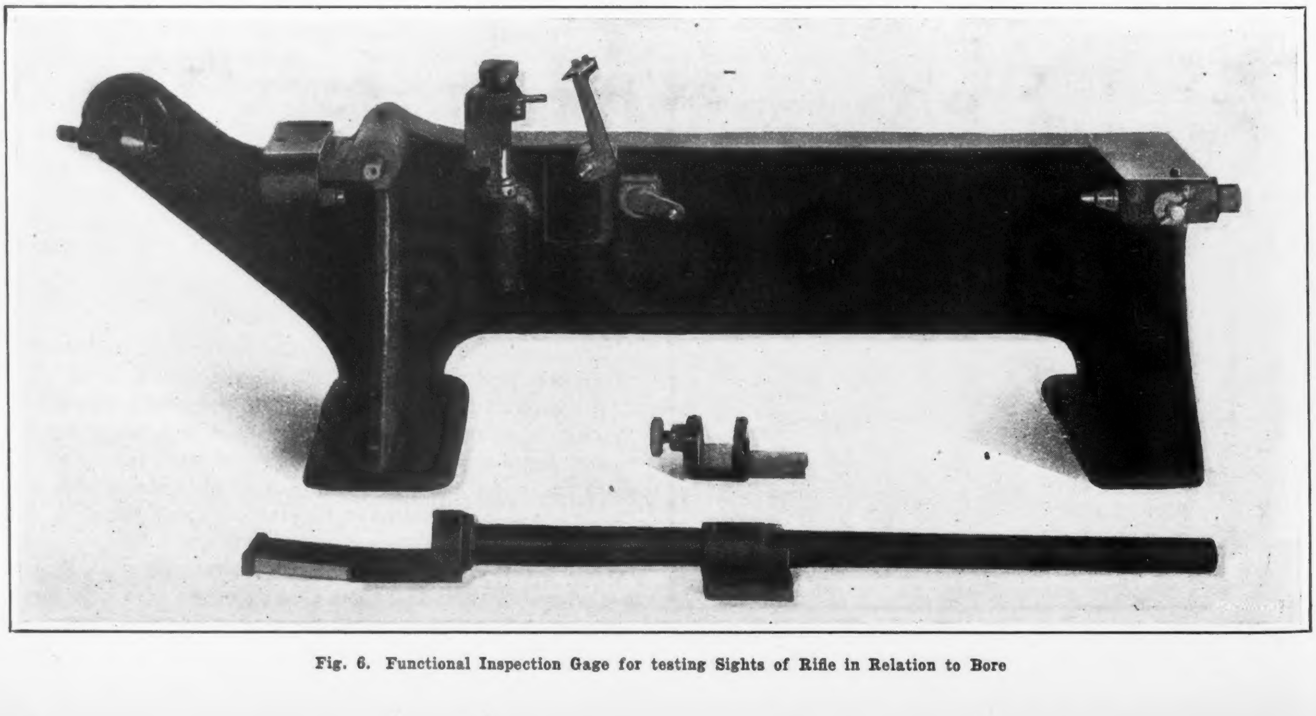


Fig. 6. Functional Inspection Gage for testing Sights of Rifle in Relation to Bore

10 per cent of the tolerance larger than the minimum size of the inspection gage, and the maximum size of the working gage is made 10 per cent of the tolerance smaller than the maximum size of the inspection gage, as shown diagrammatically at *A*, Fig. 3. An example will more clearly explain this: Assume that the tolerance for the diameter of a shaft is 0.005 inch and that the minimum dimension, as stated on the drawing, is 1.000 inch, the maximum dimension then being 1.005 inch. The inspection gage will then also have a minimum dimension of 1.000 inch and a maximum dimension of 1.005 inch. (See Fig. 4, at *A*.) The working gage, however, will have a minimum dimension of 10 per cent of the tolerance (that is, 10 per cent of 0.005 inch) added to the minimum dimension of the inspection gage. Ten per cent of the tolerance is 0.0005 inch; hence, the minimum dimension of the working gage will be 1.0005 inch. The maximum dimension of the working gage will be 10 per cent less than the maximum dimension of the inspection gage, and will, therefore, be 1.0045 inch. (See Fig. 4, at *B*). If the working gage is also made to measure the mean dimension, it will have a step, in the case of a snap gage, equal to 1.0025 inch, which is the mean dimension between the minimum 1.0005 inch and the maximum 1.0045 inch. (See Fig. 4, at *C*.)

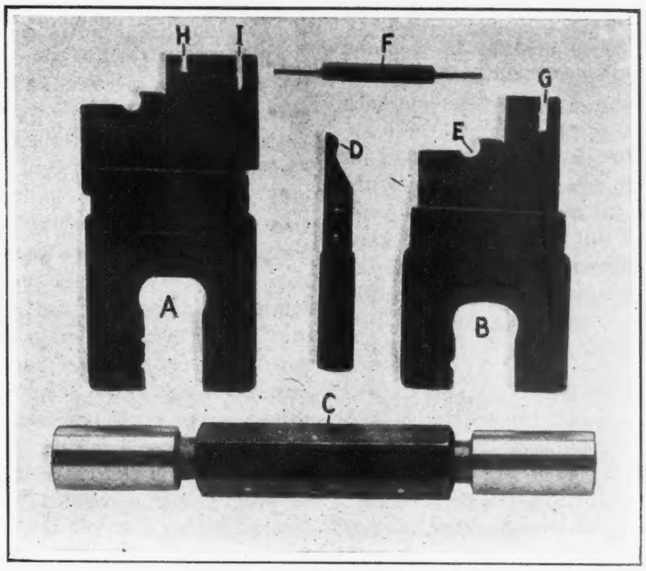


Fig. 7. Example of a Set of Working, Inspection, and Reference Gages

The object of not making the working gages and the inspection gages alike, but making the working gage to a smaller tolerance than that allowed in the inspection gage, is to make sure that all pieces passing the working gages will also pass the inspection gages. This eliminates disputes and misunderstandings between the inspection department and the shop, as it is quite certain that if a piece does not pass the inspection gages it has either been gaged carelessly in the shop and does not pass the working gages, or the working gage is so worn that it should be replaced. When the inspection and working gages are made alike, there are frequent disputes as to the justification of the inspection department in rejecting work. The working gages may wear more than the inspection gages, and, therefore, work that would pass the working gages as being correct would not pass the inspection gages, if the two were originally made alike. It would be slightly cheaper to make the working gages and the inspection gages to the same dimensions, but the saving, in most cases, is too small, as compared with the advantages gained by having working gages made to a smaller tolerance than the inspection gages.

Reference Gages

Reference gages are made to test or check the dimensions of inspection gages. The tendency is toward reducing the cost of gaging systems by making reference gages only when standard measuring plugs or other simple and accurate measuring means cannot be conveniently used. When a comparatively small number of pieces are to be made, it is also more economical not to make reference gages. When the inspection gages and working gages are made to different tolerances, as indicated in a preceding paragraph, reference gages are not provided for the working gages, due to the fact that it would require a separate set of reference gages, which is unnecessary and which would merely involve an additional expense, which is not warranted by the requirements. Working gages may be checked from the reference gage for the inspection gage by comparative measurements, using ordinary shop measuring tools. For similar reasons the reference gage for the "Not Go" inspection gage is frequently omitted, as the "Go" gage, which checks the maximum metal dimension, is the more important one. Reference gages are generally made the reverse or opposite to the inspection gages; that is, female reference gages are made for male inspection gages, and vice versa. As a rule, it is best to make the reference gages so that they fit the gaging and locating surfaces of the inspection gage to the same extent that the work fits the inspection gage. In this way, wear of the gage is more easily detected. It is not customary, however, to make a ring gage as a reference gage for a plug inspection gage, but a snap gage is used instead. The reference gage for a snap inspection gage, again, is usually a cylindrical plug gage, not a flat plug gage. By a flat plug gage is meant a plug gage that is rectangular in cross-section.

While it is the general practice to make reference gages opposite to the inspection gages, that is, using a male reference gage for a female inspection gage, and vice versa, this is not always the case. It is, for example, most convenient to compare a plug gage with another plug gage, and this holds true especially with thread gages, because it is much easier to compare the diameters of a plug thread gage with another plug thread gage than to do the checking with a ring gage.

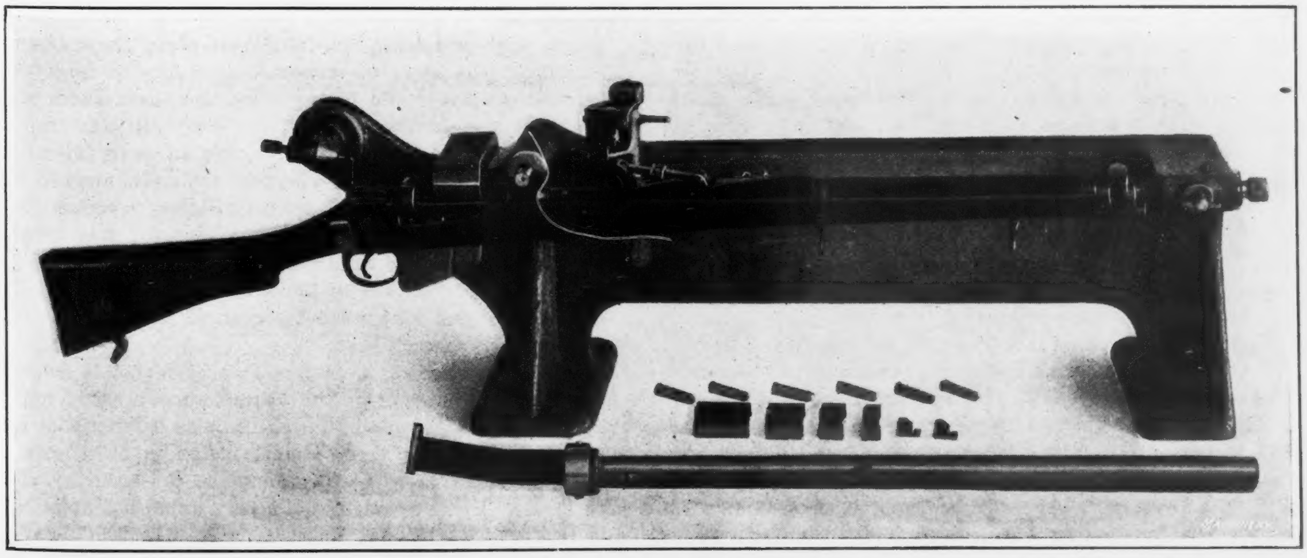


Fig. 8. Same Gage as shown in Fig. 6, with Rifle shown in Position in Gage, indicating how Gages of this Type are used

While a reference gage for a snap gage will have both maximum and minimum limits, the general practice is to make only one reference gage for contour gages, flush-pin gages, and similar types, in order to minimize the expense. The reference gage in that case ought to be made to correspond to the basic or, generally speaking, to the maximum metal dimension on the drawing of the component part for which the gages are used. The gage list that is provided with the complete set of gages should mention for which limit the reference gage is made and should contain a statement of the tolerances, so that the inspector of the gages may test the other limit also, using ordinary shop measuring tools. The gage list with this information would appear as in Fig. 5.

The Marking of Gages

There are three different ways in which the maximum and minimum limits or maximum and minimum sizes of gages may be marked. In the case of a plug gage, for example, the larger end may be marked either "max." (maximum), "high" "+" (plus), or "Not Go," while the small end would be marked "min." (minimum), "low," "—" (minus), or "Go." In the case of a snap gage, the maximum dimension would be marked "max.," "high," "+," or "Go," and the minimum, "min.," "low," "—," or "Not Go." The markings "max.," "min.," "high," and "low" refer to the dimension itself, while the markings "Go" and "Not Go" refer to the use of the gage.

The Pratt & Whitney Co.'s practice, at the present time, is to mark the words "maximum" and "minimum," generally abbreviated "max." and "min.," to indicate the part of the gage that measures the maximum and minimum dimensions. It may, however, be preferable, especially in the case of plug and snap gages, to use the expressions "Go" and "Not Go" when the gages are used by unskilled labor, as to them the latter terms are more definite and expressive. When gages are marked "max." and "min.," it is evident that in the case of a plug gage tried in a hole the "min." size will pass into the hole while the "max." size will not enter. When trying a shaft with a snap gage, however, the conditions are reversed. The "max." size will pass over the shaft, while the "min." size will not. Were the gages marked "Go" and "Not Go," the meaning of these words would, in both cases, be the same. That part of a gage marked "Go" would pass over or into the work, while the part marked "Not Go" would not pass over or into the work.

It is generally assumed by those who have had no direct experience in devising gaging systems for interchangeable work that a draftsman of fair experience and some knowledge of shop methods can give proper tolerances or limits when working out the detail drawings, so that the tool and gage designer afterward simply have to work to these tolerances or limits in the designing of the tools and gages. It should be pointed out definitely, however, that there is no engineer or designer—let alone any ordinary draftsman—who is capable, at the time the first detail drawings are made, of dimensioning with the proper tolerances and limits for efficient interchangeable manufacture any mechanism that is at all complicated. He may be capable of so setting the limits that the mechanism would function properly, but if the tool and gage designer were to follow the dimensions given without deviation, it might lead to complicated and impractical machining and tooling methods, and would probably increase the cost of manufacture beyond all reasonable limits. This has been proved time and again in ordnance and small arms work, and is not a theory, but a statement based definitely upon practical experience.

Working and inspection double-ended plug gages should have the "Go" end longer than the "Not Go" end. Working and inspection double-ended snap gages should have the "Go" end rounded to a radius of about 1/8 inch, while the "Not Go" end should be beveled for a distance of about 1/8 inch. This makes it possible to see at a glance which is the "Go" and which the "Not Go" end.

In marking the sizes on gages, the marking, when expressed in inches, should always be carried to at least three decimals, whether the last decimal is a 0 or not; for example, 0.370 and 0.200, etc. When the exact size requires more than three decimals, as, for example, 0.5798, the required number of decimals should, of course, be stamped on the gage.

When the size is expressed in millimeters, the marking should be carried to at least two decimals. For example, 6.00 and 7.40; and if more than two decimals are required to express the exact size, the required number of decimals will, of course, be given, as 3.715.

Example of a Set of Gages

Fig. 7 shows a set of gages for a part of a rifle, exemplifying the working, inspection, and reference gages used in a simple case. At *A* is shown the working gage which is here provided with three steps—maximum, mean, and minimum. The corresponding inspection gage is shown at *B*. This is provided only with a maximum and a minimum dimension, as inspection gages are never provided with mean dimensions. The corresponding reference gage is shown at *C*. This is a plug gage having at one end the maximum and at the other the minimum dimension used for checking the corresponding dimensions in inspection gage *B*. At *D* is shown the reference gage used for checking the circular portion of the inspection gage *E*, and at *F* the reference gage for the snap gage *G*. In this case, the working gage is provided at *I* with two steps for the maximum and minimum limits, while at *H* is shown the mean step, this construction being used to make unnecessary so deep a slot as would be required if all three steps were located in one slot. It may be mentioned in this connection that when plug gages such as are shown at *C* are used for reference gages only, the two ends of the gage are made of equal length.

Functional Inspection Gages

In addition to the regular inspection gages, use is frequently made of what is known as a "functional" inspection gage, which is useful for testing to see whether one or more pieces in a mechanism will actually function as required when assembled in the completed mechanism. Such functional gages consist often of a mechanism that almost duplicates the mechanism in which the part is finally to be used. Sometimes, however, they may consist of a testing mechanism built into a frame in which provisions are made for placing the object to be tested. An example of such a functional gage is shown in Fig. 6, this gage being used for testing the sights of a rifle in relation to the bore. In Fig. 8, the rifle is shown in position in the gage, indicating how gages of this type are used. Below the gage are shown dummy cartridges, which are used for testing the length of the cartridge chamber with relation to the end of the bolt. The bar shown beneath the gage in both Figs. 6 and 8 is the reference gage.

In the case of large guns, functional gages are a practical necessity on the score of economy, as otherwise large gages in great numbers would be required, and these gages would be more expensive than a functional gage. In this case, the gun mechanism is generally duplicated in every detail and the parts to be tested are inserted into the mechanism in place of the master part. This shows immediately whether or not the part will function as required. Gages of this type are especially useful when employed for final inspection by customers who merely want to know that the mechanism functions properly and who are not concerned with the details of the dimensions of each part.

In rifle manufacture, a dummy rifle or model is generally supplied to the makers of the equipment for producing the rifles. This dummy rifle is, in reality, also a functional gage, which may be used in exceptional instances by a chief inspector in order to settle a dispute as to the accuracy of the parts made. It is evident that if a part would not fit properly into this model rifle (or functional gage), it would have to be rejected.

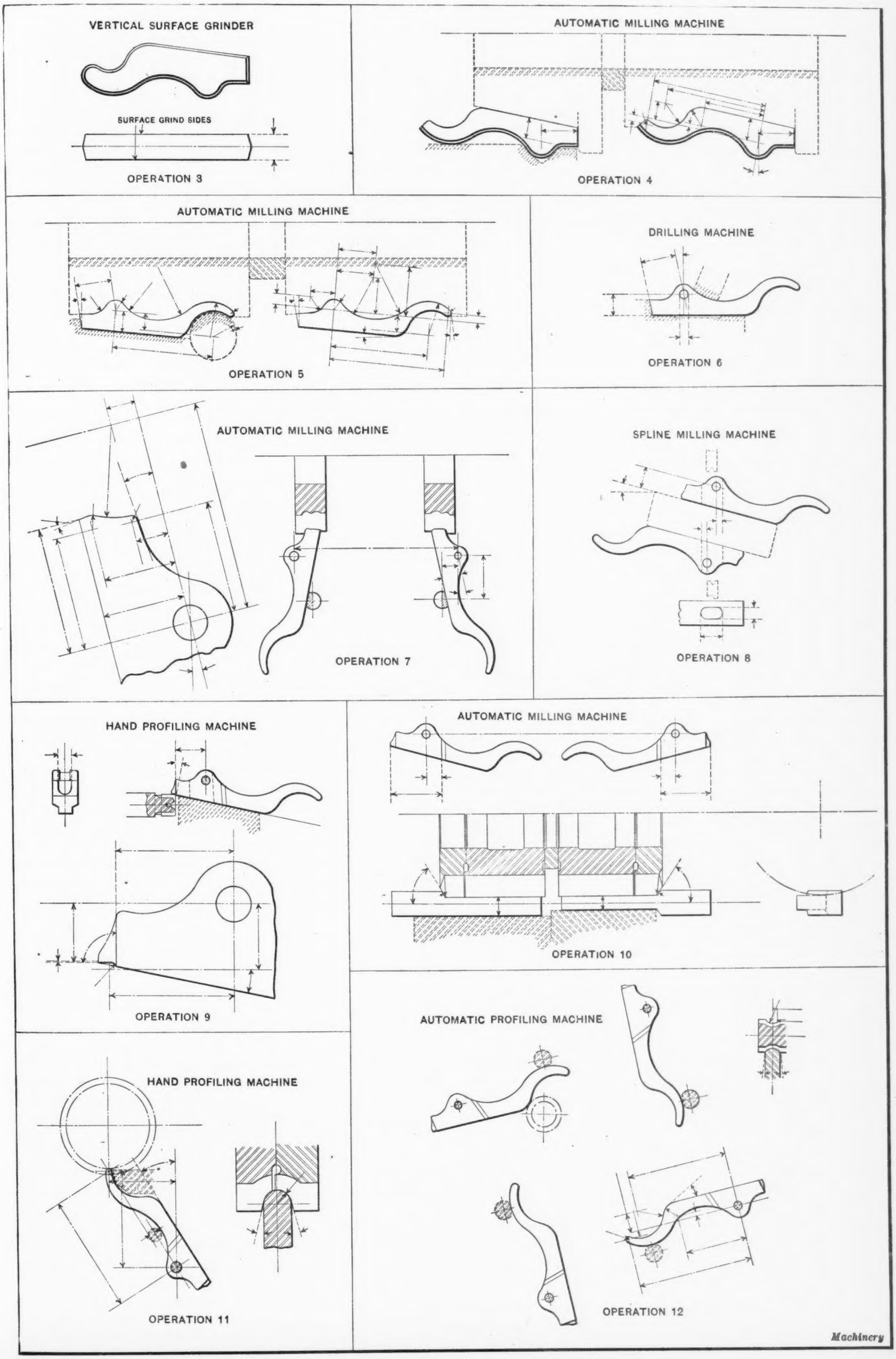


Fig. 9. Example of a Set of Operation Sheets for Rifle Trigger

Classification of Gages as Regards Design and Construction

Considered with regard to their design or construction, gages may be divided into plug and ring gages, snap gages, profile gages, flush-pin gages, and star gages, etc. The plug and ring gages may, in turn, be either plain or threaded, and the plug gage may be either cylindrical or flat. The snap gages may be solid or adjustable, and may be of either the one-piece or the built-up type. The profile gages may be either templets, receiving gages, or dial contour gages. The receiving gage, in turn, may be either solid or used with a maximum or minimum feeler plug gage. Dial gages may be either dial contour gages or lever-indicator gages of different kinds. Types of these various gages will be described in a following installment of this article.

Relation of Gaging System to Type of Work

The number of gages required and the extent to which gaging and inspection operations should be prescribed depend, to a large extent, upon the type of work to be produced and the interchangeability required, as well as upon the saving in the assembling operations that may be accomplished by an accurate gaging system. On military small arms and in the production of similar mechanisms, gages are provided for every operation, including the forging. Generally, one set of working gages is provided for each operator, the number of sets of inspection gages required depending upon the number of inspectors necessary. Reference gages, of course, can be provided in a still smaller number; in fact, a single set of reference gages is sufficient for all the inspection gages in one plant. In the manufacture of ammunition both for rifles and for heavy guns, the practice of providing working gages for every operation is also followed, and in each case it is customary to inspect the work after practically every operation.

The other extreme is met in the case where only a few parts are made for which no fixed gages are employed, except for such parts as cannot be measured by regular measuring tools, but where all other measurements are taken by ordinary measuring instruments, such as scales, micrometers, and protractors, and where the inspection is limited to the measuring of the important dimensions of the work when completed. Between these two extremes there are all kinds of conditions for which gages are used, according to the requirements. In the manufacture of small tools, for example, the operators use limit gages in their work at the machines, but the inspection is mainly limited to a thorough inspection after the completion of the tool before it goes into the stock-room or is shipped to the customer.

It would be impossible to lay down a definite rule as to when complete gaging systems should be adopted and when ordinary measuring instruments could be more profitably employed. Each case must be studied on its own merits. As an example of one of the most complete systems of gaging that has been worked out may be mentioned that of the manufacture of modern rifles. A modern rifle has from 60 to 125 parts, according to its design, and requires about 700 machining operations for its completion. For this work, not less than 1750 working gages are required. For work of this kind an equal number of inspection gages is used, and for every inspection gage there is one reference gage, so that altogether there is in one set a total of 5250 gages. Of course, in the equipment required for a complete rifle factory there may be a large number of sets of working gages and several sets of inspection gages. This is mentioned to give an idea of the magnitude of the gaging equipment that is necessary in the manufacture of a thoroughly interchangeable mechanism.

Adjustable snap gages may be profitably employed when a small number of pieces are made. These gages are provided with adjustment so that they can be set to various dimensions within a limited range, and having been so set or adjusted, they are locked and sometimes sealed in the position required so as to prevent the operator from tampering with the adjustment. Adjustable gages are also employed for taking care of the wear of the gaging points and are being more and more generally employed in the manufacture of parts where these features are of importance.

Method of Procedure in Developing a Gaging System

Briefly described, the method of procedure in developing a gaging system is as follows: A design is first made of the device required; detail drawings are made and dimensioned, but no tolerances are included. Some American manufacturers do not follow this practice, however, but place complete tolerances on the detail drawings from the beginning. European practice in regard to ordnance and small arms material differs in this respect, in that the drawings are generally sent to the manufacturer of the tool and gage equipment without tolerances being marked on them. Assuming that the design of the mechanism and the design of the tools and gages is all made under one roof, there is no doubt whatever but that the best practice is not to put complete tolerances on the original working drawings. The engineer in charge of the tool and gage design then studies the drawings of the mechanism and consults with the designer about the requirements for accuracy. Locating points for the manufacturing operations are determined upon; these should preferably be such points as are of importance in the functioning or operation of the mechanism itself when completed. When such points cannot be selected, it is well, however, as far as possible, to at least determine upon such locating points as will be left in the finished piece. It is often difficult to do so, and it is seldom that every machining operation can be performed by locating the work from one locating point.

The rule that the designer of the mechanism and the designer of tools and gages must work constantly together during the development of the tool equipment and the gaging system cannot be too strongly emphasized nor too often repeated. Failure to observe this point has caused a great deal of delay in the manufacture of ordnance during the present war, and has added hundreds of thousands of dollars to the cost of the war equipment.

One of the best methods of locating work while machining, in order to insure accuracy, consists in using two holes fitting over pins in the jigs and fixtures. Sometimes holes required in the piece are utilized, and, when permissible, holes may be drilled in the piece for locating purposes only. Again, ears may be provided on the piece through which holes may be drilled, the ears being later removed. Holes have proved to be a much better locating means than edges. Sometimes cylindrical projections may be provided on the piece, which are later removed; the projections fit into holes in the fixture and thus locate the work.

After having studied the mechanism and become thoroughly familiar with it, so that its function and the required degree of accuracy are perfectly evident to the tool designer, he determines upon the general methods by which each operation is to be performed and makes a list of the operations required on each piece. After this list has been completed, a diagrammatical drawing of each operation is made. This drawing shows the piece as it appears after each operation, gives dimensions and tolerances for that particular operation, indicates the type of machine on which the work is to be performed, the type of tool used, shows the locating points, and gives, in a general way, in a sketchy or diagrammatical form, the information that is required by the jig or fixture designer in order that he may be able to provide the proper kind of holding device for the work to be machined. The operation drawing, however, does not show the actual fixture, as this is left for a later stage.

The best way in which to arrange this operation sheet is to place the drawing for one operation only on a sheet. This makes it possible to rearrange the operations later, should it become necessary, by simply rearranging the order of the sheets in a set. The importance of using, when possible, the same locating point for all the operations should be again emphasized here, as, if that is not done, rearranging of the sequence of operations might be impossible, or might lead to

extensive changes in the equipment. These operation sheets also prove of value later during the manufacture, as they show the foreman and inspector how the work is intended to be done.

Operations for Rifle Trigger

The accompanying illustration Fig. 9 shows a set of operation sheets for the trigger for a rifle. There are altogether twelve operations required for completing the trigger, but the drawings for only ten of these operations are shown in the illustration, as Operations 1 and 2 merely show the drop-forging and the trimming of the drop-forging, respectively. Operation 3 consists of grinding the sides, which is indicated on the drawing together with the dimension to which the sides are to be ground and the tolerance. In the illustrations, the actual figures for the dimensions have been omitted, as they do not serve any specific object in illustrating the method here referred to, but arrow-heads are left to indicate what dimensions are given.

Operation 4 consists of rough-milling the entire front side and the top side of the trigger and finish-milling the straight part of the front side and the top. This is performed by a gang milling cutter. The cutter to the right performs the rough-milling operation on the top, hook, and front side, while that to the left finish-mills the top and the front side. It will be seen that the dimensions are given to such points as are used for locating the trigger in the fixture that holds it.

Operation 5 consists in rough- and finish-milling the rear side, the work being located for this operation as indicated below the trigger, while the lines above the trigger show the contour of the cutter.

In this way, all the various operations are indicated by separate drawings. It will not be necessary to refer in detail to all the illustrations, as they are self-explanatory as far as the general principle is concerned. It may be mentioned, however, that Operation 6 consists of spotting, drilling, and reaming the pin-hole; Operation 7 is the milling of the top; here part of the trigger is shown on an enlarged scale, in order to make it possible to give dimensions on the drawing; the drawing also shows that two pieces will be milled at once in a duplex fixture; Operation 8 consists of spline-milling the sear opening; Operation 9, profiling around top lug; Operation 10, milling the sides; Operation 11, milling the round on the end of the finger hook; and Operation 12, automatic profiling around the finger hook, four pieces being machined at once in a profiling machine with a rotary table. This is the last operation and completes the trigger. It will be noted that the illustrations indicate the locating points and the general principles of the tools employed, but do not show any details of the fixtures to be used.

This diagrammatical method of laying out the machining operations, indicating the work to be done, the machines on which it is to be performed, the locating points, the principles of the tools to be employed, and the dimensions required, with tolerance in all cases where the work is afterward to be gaged, has been found to be of great value in developing tool equipment and gages for interchangeable manufacture, as the work can now be distributed to a great number of draftsmen. When the work has been laid out as indicated, it is comparatively easy to proceed to design the jigs and fixtures required, as well as the cutting tools and gages.

Final Steps in Tool and Gage Design

As these operation sheets are being completed, the limits or tolerances for each operation are determined upon by the tool designer and the designer of the mechanism, in conjunction, and these tolerances are indicated on the piece on each operation sheet. A complete set of operation sheets having been made, the actual fixtures and the gages are designed, in the course of which a rearrangement of the operations and a change in the tolerances may often be necessary. The number of fixtures required for the manufacture of a given number of parts per day is also determined upon at this time, as well as the number of machines required for a predetermined output. The fixture designer must keep in mind the maintenance of the locating points as far as possible, and must thoroughly understand the preceding work that has been done by the designer of the mechanism as well as the head of the tool and gage department.

Importance of Agreement between Locating Points in Fixtures and Gages

The first and most vital principle to be observed in the development of a rational gaging system is that the locating points for the machining operations must agree with the points used for gaging the work. When the operation sheets have been laid out as explained, this will automatically insure that this very vital principle of agreement is observed. It is evident that unless the gaging is done from the same points as are used for locating the work in the jigs or fixtures, it would be impossible to obtain a product that would meet the requirements of the gages.

When the complete tool and gage equipment has been made, it is tested by making a number of pieces for trying out the fixtures and the gages. In the case of small work, like rifle manufacture, as many as a hundred pieces may be made in order to give the tooling equipment and the gages a thorough try-out as to their suitability for turning out the work both accurately and within the time required.

The most important subdivision of the whole subject of establishing a gaging system is the determination of suitable tolerances. Had this subject been thoroughly understood at the beginning of the present war, a great deal of time and expense would have been saved in the manufacture of war materials and in the making of the tools and gages for this purpose. It should be emphasized that the original design should provide for as few fits as possible, and liberal clearances should be provided in every case where there is no actual fit.

Methods of Dimensioning Drawings

The methods used for dimensioning drawings are of the greatest importance in interchangeable work for which a gaging system has to be developed. It is generally assumed by those who have had no direct experience in this work that a draftsman of fair experience and some knowledge of shop methods can properly dimension the drawings, giving the tolerances or limits, when working out the detail drawings, so that the tool and gage designers afterward simply have to work to these tolerances or limits in the designing of the tools and gages. It should be pointed out very definitely at the outset, however, that there is no engineer or designer—let alone any ordinary draftsman—who is capable, at the time the first detail drawings are made, of dimensioning, with the proper tolerances and limits for efficient interchangeable manufacture, any mechanism that is at all complicated. He may be capable of so setting the limits that the mechanism would function properly, but if the tool and gage designer were to follow the tolerances given without deviation, it might lead to complicated and impractical machining and tooling methods, and would probably increase the cost of manufacture beyond all reasonable limits. This has been proved time and again in ordnance and small arms work, and is not a theory, but a statement based definitely upon practical experience.

In ordinary work, limits or tolerances may be given for comparatively simple dimensions, such as those of thread diameters, holes and shafts, slots, or anything where it is evident how the work will be located when machined, and how it will be gaged while being machined and when inspected. To go further than this, however, is impossible, or, at least, impracticable, unless the complete machining and gaging methods are determined upon at the time when the first detail drawings are made. Instead, the tolerances on the drawings, except for the simple dimensions mentioned above, are added to the drawings after the machining operations have been determined upon and the tooling equipment and the limit gages have been planned, and are then entered on the drawing merely as a record.

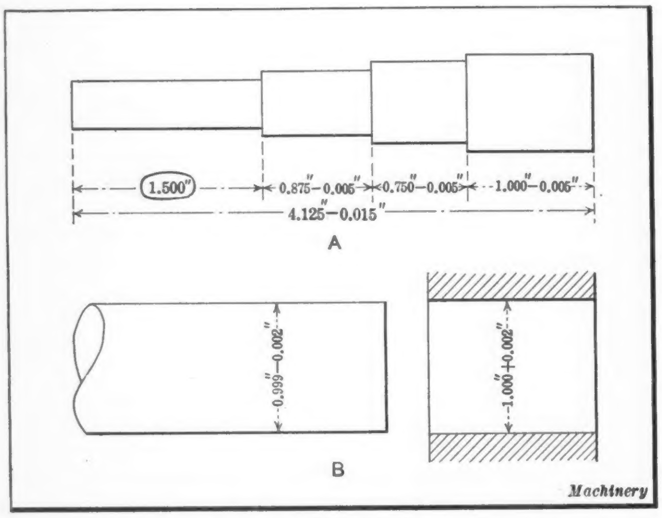


Fig. 10. Methods used in dimensioning Drawings

Procedure in Making Drawings

As an example of the ideal procedure in the making of drawings for very accurate work, such as small arms, the following outline is given: There are three stages in the design. First, the mechanism should be designed with a view to obtaining proper working or functioning of the parts. In the case of a rifle, for example, the first design includes merely the interrelation of the various parts, so that the mechanism will perform the exact function that is required of it. This part of the design could well be called "functional design." The functional design having been completed, the work enters upon its second stage, which may be called "economy-of-manufacture design." At this stage, many of the parts may be redesigned in detail in order to cheapen their manufacture and reduce the mechanism to a commercially practicable manufacturing proposition. After the mechanism has been reduced to what appears to be the simplest design for manufacturing purposes consistent with the proper functioning of the parts, the third stage of the design is entered upon, which is merely a subdivision of the economy-of-manufacture design, and which consists in making such modifications as are required at the time when the tools and gages are designed. When the detail drawings of the mechanism come into the hands of the tool and gage designer, it is nearly always necessary to make certain modifications in the design, in order to adjust it to practical tool design and gaging methods. This is true, irrespective of the fact that the designer of the mechanism has used proper judgment in its design to facilitate manufacture. There are always a few changes that need to be made when the final tool design and the gages are worked up in detail.

The first principle that must be considered in the establishment of tolerances—and the one that unfortunately is most often violated—is that tolerances should not be determined upon with reference to what would be the minimum tolerances that could be obtained by modern machining methods; but they should be established with reference to what are the maximum tolerances that are permissible in the mechanism without interfering with its proper purpose and action. Were this principle always kept in mind by designers, the expense of manufacture would be greatly reduced.

Necessity for Cooperation between Designer of Mechanism and Designer of Tools and Gages

Assuming that the design is being worked out along the lines outlined in the preceding paragraphs, then for very accurate work, such as rifles, assembly and detail drawings are first required showing the general design and containing general dimensions without tolerances; or, at least, with only temporary or provisional tolerances, as these, of course, may give the tool and gage designer a general idea of the requirements, so as to provide him with a tentative basis for his work. Of course, any tolerances that are absolutely required for the proper functioning of the device should be placed on the drawing; that is, tolerances which, if exceeded, would definitely prevent the mechanism from working properly. The designer of the tools and gages then studies the mechanism so as to fully understand its action, and the designer of the mechanism and the tool and gage designer must work constantly together until the complete tool and gage equipment has been determined upon and the proper tolerances have been adopted. The same man should be at the head of the tool and gage design in order that the tool and gage equipment may be worked out with the same principles in mind as regards locating points, methods of machining and gaging, etc.

In the dimensioning of the provisional drawings, one of the important points to be considered is that, whenever possible, the dimensions or arrow-heads should be made from such points as can be used as locating and gaging points. In the past, this has been only partially observed. It has generally been considered that if all the dimensions were on the drawing from some important surface or center, that was all that was required.

The tolerances and limits are then placed on the drawings as the tool and gage equipment for the part is planned on the operation sheets. The designer of the mechanism will decide upon the tolerances that are permissible, and the tool and gage designer then decides upon machining methods and tooling and gaging equipment that will produce the parts with the required accuracy and in a commercial manner. Finally, the detail drawings of the mechanism are completed by placing upon them the tolerances and limits determined upon during the working out of the machining methods and the design of the tools and gages. The drawings then become a permanent record of how the mechanism is actually made with the equipment provided.

The point that the designer of the mechanism and the designer of the tools and gages must work constantly together during the development of the tool equipment and the gaging system cannot be too strongly emphasized nor too often repeated. Failure to observe this point has caused a great deal of delay in the manufacture of ordnance during the present war and has added hundreds and thousands of dollars to the cost of the war equipment.

As an example of the difficulties that result from an attempt to provide complete dimensions for tolerances or limits on a set of drawings without consulting the makers of the tool and fixture equipment and without considering commercial possibilities of manufacture, it may be mentioned that in one case a design was submitted to the Pratt & Whitney Co. on which complete limits were provided. It was found that before these drawings were submitted to the Pratt & Whitney Co. for the making of a tool and gage equipment, they had been submitted to another factory making a similar mechanism

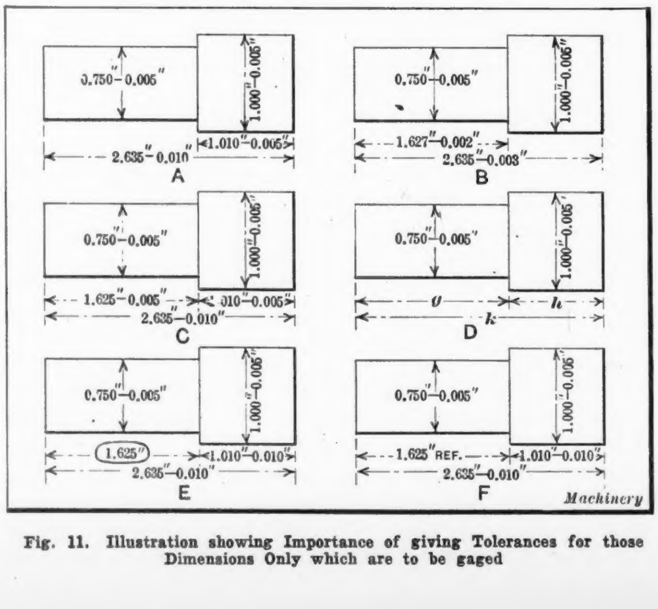


Fig. 11. Illustration showing Importance of giving Tolerances for those Dimensions Only which are to be gaged

to that for which the design was provided. At this factory, they knew from previous experience that the tolerances given were too close for practical manufacturing work, and a new set of drawings were made on the strength of their recommendations, giving more liberal tolerances. Still these drawings were made without consulting the tool and gage designers, and when the drawings were finally submitted to them, it was found necessary to make a third set of drawings, which was completed after the tools and gages had been made, and which contained the correct tolerances, permitting of commercial methods of manufacture. Altogether, several thousand dimensions were changed during this procedure, delaying the work and increasing the cost in an unwarranted manner.

Detail Instructions for Dimensioning of Drawings

The first principle that must be adhered to in the dimensioning of drawings that are to indicate definitely clearances and tolerances is that the maximum metal dimensions should be given as basic dimensions, and from these the tolerances should be subtracted, in the case of male parts, or to them the tolerances should be added, in the case of female parts. The object of giving the maximum metal dimensions is, in the first place, to provide a very simple means for adding up the dimensions to check them up with other dimensions, as the adding of all the maximum metal dimensions will give an over-all maximum metal dimension, as illustrated at *A* in Fig. 10. By adding all the tolerances, the total tolerance is also obtained. It makes the changing of tolerances much simpler, as the basic dimensions need not be changed, as long as no change is contemplated in the initial clearances. Furthermore, the difference between the two maximum metal dimensions on two component parts always indicates the amount of the initial clearance. For example, if the minimum size of a hole is 1.000 inch and the maximum size of a shaft is 0.999 inch, then these two dimensions are the maximum metal dimensions, respectively, for the hole and the shaft, and the initial clearance, which is always the minimum clearance, is apparent at a glance.

Great difficulty is experienced with designs that do not provide for initial clearance on the original drawings. While the designer, at the time that the detail drawings for the component parts of a mechanism are made, cannot and ought not to determine upon the tolerances, he should, as a general rule, determine upon the kinds of fit that he requires, which, in turn, makes it possible for him to dimension the drawings with the maximum metal dimensions, thus providing for the initial clearance at the time the design is made and the first or provisional detail drawings are completed.

In the present case, it is, of course, 0.001 inch. Now the permissible tolerances will be taken care of by writing the dimension of the hole as 1.000 + 0.002, and the dimension of the shaft as 0.999 — 0.002, as indicated at *B* in Fig. 10. The use of the maximum metal dimensions has the added advantage of showing, at a glance, that there is no interference between the parts under any conditions.

Summing up, the first drawings should generally give the maximum metal dimensions for all parts, but without tolerances. By giving the maximum metal dimensions, the initial clearances are also given, and these clearances it is possible

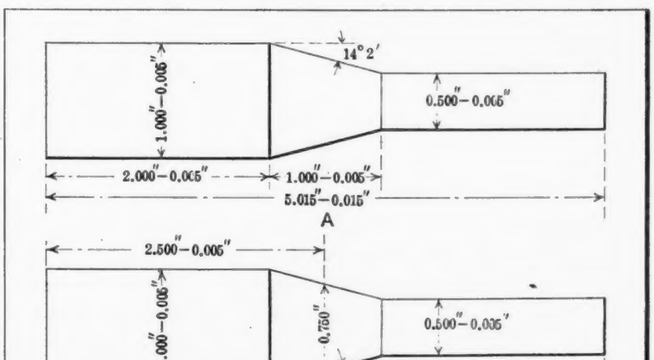


Fig. 12. Method for giving Tolerances for Tapered Work

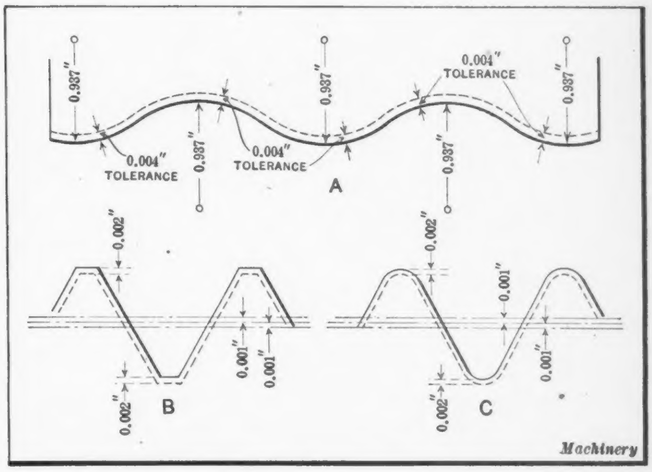


Fig. 13. Method of showing Tolerances on Contours and on Threads

for the designer to determine upon at the time that he makes his first detail drawings, because he must know the amount of the minimum clearance that is permissible in the mechanism, and these minimum clearances are also the initial clearances. It should be emphasized that the original design should provide for as few fits as possible, and liberal clearances should be provided for wherever there is no actual fit.

Repetition of Dimensions—Unnecessary Dimensions

Another point to be taken into account is to avoid the repetition of dimensions. One dimension in one view, and in one view only, is sufficient; it is better and safer not to repeat the same dimension in another view, and certainly it should not be repeated in the same view in another location. The repeating of dimensions causes a great deal of trouble when drawings are changed, as some of the dimensions are likely to be overlooked. In one instance, a drawing had the same dimension repeated six times. It is evident that if a change was made in this dimension, it would be likely that one of the five repeated dimensions might be overlooked, as the designer or draftsman making the change would hardly expect to look for the dimension in all the views, and certainly not twice in the same view.

Another fundamental rule is that no more dimensions than are necessary to make a piece should be placed on the drawing. If only the basic dimensions, without tolerances, were given, there would be no harm; in fact, it would be useful to give additional dimensions, such as over-all dimensions, etc. But when tolerances are expressed, such additional dimensions are not only unnecessary, but very confusing. They are unnecessary because dimensions which are interdependent on others already gaged will take care of themselves. How confusing they become is best shown by an example.

In Fig. 11 is shown at *A* a piece that is properly dimensioned, and which gives the gage designer the full information he requires for making gages. If he makes two snap gages, one that measures the over-all dimension *k*, and one the dimension *h*, as indicated at *D*, all conditions are fulfilled. Should the draftsman, in making the original detail drawing, however, attempt to put on dimensions for all three lengths, *g*, *h*, and *k*, it is most likely that he would dimension the drawing as at *C*. Correctly interpreted, this drawing means that all three length dimensions must be made according to the drawing, and this can be accomplished only by two gages that gage dimensions *g* and *h*, but not by gaging *k* and *h*, or *k* and *g*. Why this is so needs an explanation. Assume that an attempt is made to gage, say, *k* and *g*, and that it is believed that if these were found correct, this would cause dimension *h* always to be correct also. Analyzing the case, *k* may be 2.635

inches and g may be 1.620 inch. Subtracting g from k, we have h equal to 1.015 inch, which is 0.005 inch too large, according to the drawing. Again, k may be 2.625 inches and g may be 1.625 inch. In that case, the actual dimension of h would be 1.000 inch, which is 0.005 inch too small. But g is the very dimension that should have agreed to the tolerance specified at A. Hence, it is clear that by adding the dimension g, and then gaging only two dimensions, an error has been introduced that would not have occurred if the drawing had been left as shown at A, and h and k gaged as there directed.

However, should it be found more convenient for some reason to gage dimensions k and g instead of h and k, still maintaining the required limits for dimension h, which is assumed to be the most vital dimension, then the drawing must be dimensioned as at B. Here, if k measures 2.635 inches and g 1.625 inch, then h will be 1.010 inch; and if k measures 2.632 inches and g 1.627 inch, then h will measure 1.005 inch, which agrees with the limits given at A; but in accomplishing this result, it will be noted that it has been obtained at the cost of a material reduction in the tolerance otherwise permissible on dimension k.

This shows how important it is that only those dimensions that are to be actually gaged are given with tolerances on the drawing. In a case where it would be convenient to have a figure on the drawing which is not to be used for gaging and for which, therefore, no tolerances are given, this figure may be surrounded by a line, as indicated at E, or the abbreviation "Ref." (reference) may be added after the dimension, as indicated at F. The latter method is now used by the United States Ordnance Department. These indications show at a glance that the dimension is added for reference only, and is not intended as an actual gaging dimension.

In general, there is a misconception as to the tolerances ordinarily permissible in the building of machines and other mechanisms. Engineers and designers, as well as other men engaged in the machine building field, generally believe that the tolerances on what are considered high-class mechanisms are much smaller than they actually are; and hence, in designing such mechanisms, unless they thoroughly study the subject, they are likely to require tolerances that are by no means necessary.

Dimensioning Tapers

All dimensions must be given so that they can be understood in but one way. A difficulty of this kind is met with in the dimensioning of tapered work, as indicated in Fig. 12. If a piece such as that shown were dimensioned simply with the tolerances for diameters and lengths, as shown at the top, the gage designer would be at a loss to know how to produce a proper gage for gaging the angle, as he is guided not by the tolerance on one dimension, but by the tolerances on two diameters and two lengths in determining the proper dimensions for gaging the tapered part. One way of dimensioning a drawing to indicate the accuracy required in a tapered part is as indicated at the bottom in Fig. 12. A diametral dimension is given somewhere on the tapered part, this diameter having no tolerance. Then a length dimension provided with the required tolerance is given from some point with reference to which the tapered part must be properly located. When a piece is dimensioned in this manner, there can be no doubt as to the dimensions of the limit gages.

Tolerances, where a taper depends both upon diametral dimensions with tolerances and length dimensions with tolerances, may be called "compound tolerances." Such tolerances should always be avoided on drawings. The case shown in Fig. 12 is one of the most common cases of compound tolerances. They occur, however, in many other instances and present one of the confusing conditions that are met with by the tool and gage designer in interpreting drawings.

Dimensioning Contours

In the dimensioning of contours when tolerances are given, it is sometimes difficult to make the drawing perfectly clear if, for example, a radius is given with a tolerance in the same way as the tolerance would be expressed in the case of a diameter of a hole or the length of a stud. In cases of this kind, the best method is often to draw a dotted line outside or inside the full line that gives the maximum metal dimensions, and to give a dimension between these full and dotted lines, indicating the tolerance as shown at A in Fig. 13. This is particularly useful when the tolerance varies at different points of the contour. Screw thread tolerances may be shown in the same way, as indicated at B and C.

Methods of Designating Tolerances on Drawings

There are a number of different methods for designating tolerances on drawings. The most common way, no doubt, is that of writing the tolerances as a certain amount above or below a basic size, as, for example, 0.998 ± 0.001 inch. This method, however, will not apply directly when maximum metal dimensions are given, as in that case the tolerance will be given either with a plus sign or with a minus sign, but both signs will not be used at the same time. This is clear, of course, from what has been said in the foregoing about maximum metal dimensions; hence, the tolerance in cases of that kind would be given as 0.999 — 0.002 inch, or 0.997 + 0.002 inch, according to whether a male or female piece were dimensioned.

In order to reduce the number of figures that have to be written on the drawings, the Pratt & Whitney Co. has developed a simplified method of expressing tolerances on tool and gage drawings. If it is desired to express the following dimension: 1.375 — 0.004, the Pratt & Whitney Co.'s practice is to write this 1.375 — 4, it being understood that the last figure (4) indicates the tolerance in the same units as the last decimal figure in the basic dimension; hence, when the basic dimension has three decimals, the tolerance will be expressed in thousandths of an inch. If the basic dimension has four decimals, the tolerance figures represent ten-thousandths of an inch. For example, 1.2736 — 3 is equivalent to 1.2736 — 0.0003 inch.

This method permits of using more than one figure to express the tolerance, if required, but it is always understood that units in the value expressing the tolerance are equivalent in value to the last unit value of the decimals in the basic dimension. For example:

1.23 — 2 = 1.23 — 0.02	1.400 + 5 = 1.400 + 0.005
1.60 + 3 = 1.60 + 0.03	1.460 + 25 = 1.460 + 0.025
1.60 + 15 = 1.60 + 0.15	3.6967 — 5 = 3.6967 — 0.0005
1.395 — 5 = 1.395 — 0.005	0.9675 + 15 = 0.9675 + 0.0015

This method is exceedingly convenient when the draftsmen as well as the men in the shop have become used to it, but it takes some time to train the force to understand in all instances the proper meaning of the tolerance expressed in this manner. Of course, it is evident that where tolerances are either above or below a basic size, the method is equally applicable, as, for example, 1.748 ± 1, which means the same as 1.748 ± 0.001. Furthermore, the system is understood to imply that when no tolerance is given, a tolerance of + or — one-half of the last decimal unit is permitted; for example, 1.728 would imply a dimension of 1.728 ± 0.0005; in the same way 1.20 would mean 1.20 ± 0.005; and 1.7963 would mean 1.7963 ± 0.00005.

Practical Tolerances for Interchangeable Manufacture

Perhaps the most important subdivision of the whole subject of establishing a gaging system is the determination of suitable tolerances. Had this subject been thoroughly understood at the beginning of the present war, a great deal of time and expense could have been saved in the manufacture of war materials, and in the making of the tools and gages for this purpose.

The first principle that must be considered—and the one that, unfortunately, is most often violated—is that tolerances should not be determined upon with reference to what would

be the minimum tolerances that can be obtained by modern machining methods, but should be established with reference to what are the maximum tolerances that are permissible in the mechanism without interfering with its proper purpose and action. Were this principle always kept in mind by designers, the expense of manufacture could be greatly reduced; and it is especially of importance, at the present time, in connection with the manufacture of ordnance and of other classes of war materials, because if the tolerances are determined with this principle in mind, the time required for the manufacture of war materials could be greatly reduced and the equipment of our armies could be much more rapidly obtained and at a reduced cost.

Larger Tolerances are Permissible than is Ordinarily Believed

In general, there is a misconception as to the tolerances ordinarily permissible in the building of machines and other mechanisms. Even engineers and designers, as well as other men engaged in the machine-building field, ordinarily believe that the tolerances on what are considered high-class mechanisms are much smaller than they actually are; and, hence, in designing such mechanisms, unless they thoroughly study the subject, they are likely to require tolerances that are by no means necessary.

A rifle is a highly accurate mechanism. Generally speaking, the tolerances for a rifle might be considered as small as the tolerances required in any ordinary machine or device, and yet it probably will surprise many to find that the average tolerances on the important dimensions on a first-class rifle are about 0.004 inch. The country has been educated for years and years, particularly by salesmen, to the belief that many firms are working, in practically every case, to a tolerance of a thousandth of an inch; hence, there is a widespread belief that in commercial interchangeable manufacture there is no difficulty in maintaining tolerances that do not exceed 0.001 inch, but nothing could be more erroneous.

A revision is necessary of the ideas regarding accuracy in interchangeable manufacture. It is possible, of course, by the application of expensive machining operations, to obtain an accuracy, even in interchangeable manufacture, of 0.001 inch, or even less than this, but such accuracy is not necessary for most purposes, and is highly undesirable when not required, from the point of view of economy in manufacture.

This point cannot be too strongly emphasized. A revision is necessary of the ideas regarding accuracy in interchangeable manufacture. It is possible, of course, by the application of expensive machining operations to obtain an accuracy, even in interchangeable manufacture, of 0.001 inch, and even less than this, but such accuracy is not necessary for most purposes, and is highly undesirable from the point of view of economy in manufacture. As an example of how greatly the ideas as to the required tolerance vary, it may be mentioned that the bolt of a rifle is required by one nation to be accurate to a tolerance of 0.001 inch, while the rifles of another nation have a tolerance of 0.010 inch. In general, it may be said that the tendency when using limit gages, particularly in the manufacture of war materials, has been toward too small tolerances, which has reduced the output and increased the expense.

Tolerance on Work is Always Less than Tolerance on Drawing

Another point that should be thoroughly understood is that the drawings of the detail parts of the mechanism, when giving limits or tolerances, give the size of the maximum and minimum limit inspection gages; hence, it is evident that if the gages are made inside these dimensions with a slight tolerance in the gage itself, as, of course, is always required, the actual tolerance of the work usually is somewhat less than that indicated by the dimensions on the drawing; and, in addition, it must be remembered that the greater percentage of the parts made will come well within the limits. Furthermore, when working gages are made as outlined in a preceding paragraph, with dimensions 10 per cent of the tolerance below or above the maximum and minimum inspection gages, this also reduces the tolerance on the work as produced in the shop. Hence, the tolerance on the drawing must be liberal enough to allow for this decrease in the actual shop tolerance.

Tolerances for Different Machining Operations

To lay down in definite figures the tolerances that are obtainable in interchangeable manufacture is something that has seldom before been attempted. In the following paragraphs, however, are given figures based upon the experience and the practice of the Pratt & Whitney Co. in making equipment for rifle manufacture, and while some of these figures may vary with the circumstances, they may be laid down as denoting average minimum values for this and similar classes of work. It should, of course, be understood that when the function of the part to be made allows of greater tolerances than those specified in the following, the tolerances should be made as liberal as possible, as already referred to. It is presupposed that the machines used are in good condition and that reference is made only to interchangeable manufacture—that is, the tolerances given should be obtained day after day and month after month with the proper tooling equipment in the hands of men with a fair knowledge of its use. Under tool-room conditions, in tool- and gage-making, and when machines are "built" rather than "manufactured," of course, much closer tolerances are obtainable, but the figures in the following are not intended for work of this kind.

Automatic Screw Machine Work—For threading in automatic screw machines, a tolerance on the outside diameter of 0.003 inch and on the pitch diameter of 0.002 inch can be maintained; in turning with a box-tool, 0.003 inch. In drilling, the tolerances depend upon the diameter of the drill. For drills from Nos. 60 to 30, a tolerance of 0.002 inch can be maintained; for drills from Nos. 30 to 1, 0.003 inch; for drills from 1/4 to 1/2 inch in diameter, 0.004 inch; for drills from 1/2 to 3/4 inch in diameter, 0.005 inch; and for drills from 3/4 to 1 inch in diameter, 0.007 inch.

The tolerances that may be maintained on shoulder work depend largely upon the design of the tools. The accuracy may also be greater when one tool is used than when a number of tools are used for several different cuts. The condition of the machine and the feeding mechanism also are of importance. In general, it may be said that shoulder work on automatic screw machines requires tolerances of from 0.003 to 0.005 inch.

In forming with a forming tool, the tolerances depend upon the width of the tool. For widths less than 3/4 inch, a tolerance of 0.003 inch can be maintained; for widths between 3/4 and 1½ inch, 0.004 inch.

Hollow-milling is, at best, an inaccurate operation, and should be used for roughing only. The tolerances depend upon the diameter of the cut. For hollow-milling from 3/16 to 1/2 inch, a tolerance of 0.006 inch can be maintained; from 1/2 to 3/4 inch, 0.008 inch; and from 3/4 to 1 inch, 0.010 inch.

Reaming permits of tolerances of 0.001 inch for sizes up to 1/2 inch in diameter, and 0.0015 inch for sizes from 1/2 to 1 inch.

Power Milling—A flat surface on small work such as rifle manufacture may be milled to a tolerance of from 0.002 to 0.003 inch, provided only a single surface is milled at a time. If two or more surfaces are milled simultaneously, one surface may be milled to a tolerance of 0.002 inch, but the other surface could hardly be held to a closer tolerance than 0.005 inch. In general, however, a tolerance, for milling, of from 0.004 to 0.005 inch should be permitted on all surfaces, because while a tolerance of 0.002 inch is possible, it is not practicable if economy of manufacture is an item to be taken into consideration, which, of course, it always should be.

Straddle-milling permits of a tolerance of 0.003 inch, and contours milled by form cutters require a tolerance of at least 0.005 inch.

The tolerances for slots milled by end-mills in one cut depend upon the diameter of the mill, which, of course, equals the width of the slot. Assuming that the mill runs as true as commercially possible, and that the depth of the slot is not

materially deeper than the diameter of the mill, then for widths between 1/4 and 1/2 inch, a tolerance of 0.004 inch can be maintained; for widths between 1/2 and 3/4 inch, 0.006 inch; and for widths between 3/4 and 1 inch, 0.008 inch.

Hand Milling—For hand milling, it is advisable to provide slightly greater tolerances than for power milling, on account of the less even feeding motion and the jerky action that is, therefore, likely to take place.

Profiling—Profiling operations performed in hand profiling machines require a tolerance of 0.004 inch on simple contours and 0.008 inch on more complicated contours. (These are radial and not diametral tolerances.) For work done in automatic profiling machines, tolerances of from 0.005 to 0.015 inch are required according to the nature of the surfaces milled. The tolerance of 0.015 inch applies to extreme cases only.

Spline Milling—Spline milling operations performed in special spline milling machines with fish-tailed cutters require rather large tolerances, depending upon the width of the spline.

On the width dimension of the slot, a tolerance of 0.005 inch can be maintained. If the slots are to be shaved afterward, tolerances between 0.005 and 0.010 inch are used, according to the width of the slot. In milling shallow keyways, a tolerance of 0.002 inch is maintained.

Vertical Shaving—For operations performed in vertical shaving machines, which are, in reality, small slotting machines and which are used for squaring the ends of slots, a tolerance of 0.004 inch may be maintained both as regards the width and the end of the slot.

Thread Milling—While it is possible, with a machine extremely well taken care of and a very accurate form of cutter, to maintain a tolerance of 0.001 inch for short pieces on the pitch diameter, and a tolerance of 0.002 inch on the outside and bottom diameter, it is impracticable to give tolerances for interchangeable manufacture more accurate than 0.002 inch for the pitch diameter and 0.004 inch for the outside and bottom diameter. Tolerances on the outside diameter refer only to Whitworth or other threads with a formed top of thread. It is evident that here the larger tolerance given for the outside diameter does not affect the accuracy or working of the thread, because the apex of the thread is of little value and the important dimension is the pitch diameter.

Lathe Work—In rough-turning, the minimum tolerance on the work for diameters from 1/4 to 1/2 inch should be 0.005 inch; for diameters from 1/2 to 1 inch, 0.007 inch; for diameters from 1 to 2 inches, 0.010 inch; and for larger diameters, 0.015 inch. For finish-turning, the tolerance on the work for diameters from 1/4 to 1/2 inch may be 0.002 inch; for diameters from 1/2 to 1 inch, 0.003 inch; for diameters from 1 to 2 inches, 0.005 inch; and for larger diameters, 0.007 inch. When tolerances requiring the work to be more accurate than this are given, the work should be ground; generally, grinding is, whenever possible, the most accurate as well as the cheapest method of finishing cylindrical work in any case.

In boring holes in the lathe, diameters of from 1 to 2 inches may be rough-bored with a tolerance of 0.008 inch, and holes of larger diameter, with a tolerance of from 0.010 to 0.015 inch. In finish-boring, tolerances of 0.005 inch may be maintained for diameters less than 2 inches, and of from 0.007 to 0.010 inch for larger diameters. Closer tolerances, when required, are taken care of by reaming or grinding.

For thread cutting in the lathe, whether outside or internal threading, tolerances on the pitch diameter of from 0.0015 to 0.002 inch may be maintained.

Drilling—For drilling in a drilling machine using suitable jigs and fixtures, the tolerances depend upon the diameter of the hole—the larger the hole, the larger should be the tolerance. The following m i n i m u m tolerances may be maintained: For drills from Nos. 60 to 30, 0.002 inch; for drills from Nos. 30 to 1, 0.003 inch; for drills from 1/4 to 1/2 inch, 0.004 inch; for drills from 1/2 to 3/4 inch, 0.005 inch; for drills from 3/4 to 1 inch, 0.007 inch; and for drills from 1 to 2 inches, 0.010 inch.

Planing and Shaping—In planing and shaping comparatively large pieces, such as the base and slides of machine tools, tolerances of from 0.005 to 0.010 inch may be maintained.

Grinding—Grinding tolerances for interchangeable manufacture may be assumed as follows: Cylindrical grinding, 0.0005 inch; surface grinding, 0.0005 inch; grinding in vertical surface grinding machine, 0.002 inch. Under very favorable circumstances, tolerances of 0.001 inch are maintained in vertical surface grinders, but to maintain so small a tolerance requires a machine in first-class condition and great care on the part of the operator to prevent dirt or chips from coming between the work and the machine table. For practical purposes, in interchangeable work, 0.002 inch should be considered the minimum tolerance for vertical surface grinding.

In gage grinding, it is possible to maintain tolerances of 0.00025 inch for both cylindrical and surface grinding.

Turret Lathe Work—In the turret lathe, the tolerances on diameters may be assumed as a minimum of 0.004 inch, and on shoulder work, as 0.003 inch. In this case, of course, a great deal depends upon the tooling equipment, the care with which the machine is maintained in a first-class condition, as well as upon the operator.

Reaming—In hand reaming, for diameters up to 1 inch, a tolerance of 0.0004 inch may be maintained; for diameters above 1 inch, 0.0006 inch. For machine reaming, the tolerance for diameters up to 1/2 inch may be assumed as 0.0005 inch; for diameters of from 1/2 to 1 inch, from 0.00075 to 0.001 inch; and for diameters above 1 inch, 0.0015 inch.

Die Work—On small work using high-class sub-press dies, it is remarkable what close tolerances may be maintained. It is stated that with the punch and die kept perfectly sharp, with the fits of the sub-press die in the best condition, and with small work, tolerances of 0.0005 inch may be maintained.

Tolerances for Center Distances—On important work, a tolerance of from 0.001 to 0.002 inch may be maintained for center distances between two holes. Such close tolerances, however, are very difficult to maintain, and can only be obtained by the very best tooling equipment and machining methods.

Tolerances for Screw Threads—In connection with the work that has been done for the interchangeable manufacture of rifles at the Pratt & Whitney Co., tolerances for screw threads have been determined upon, suitable for work of this kind, and insuring interchangeability as well as limits obtainable in commercial practice. The accompanying table shows the tolerances that have been adopted for the U. S. and the Whitworth forms of thread, for pitches of from 20 to 50 threads per inch. In the illustration, the line marked *H* indicates the maximum dimension for the hole, while the line marked *S* indicates the minimum dimension for the screw. The heavier line marked *H* and *S* shows the basic diameter, which is the maximum diameter for the screw and the minimum diameter for the threaded hole. It will be seen from the dimensions given on the drawing, as well as from the accompanying table "Tolerances for Tapped Holes and Screws," that the tolerance on the outside diameter of tapped holes is equal to + 0.004 inch on the outside and the root diameters, while it is equal to the basic diameter + 0.002 inch on the pitch diameter. For screws, the tolerances are

The rifle is a highly accurate mechanism. Generally speaking, the tolerances for a rifle might be considered as small as the tolerances required in any ordinary device, and yet it probably will surprise many to find that the average tolerances on the important dimensions of a first-class rifle are about 0.004 inch.

The first and most vital principle to be observed in the development of a rational gaging system is to have the locating points in the jigs and fixtures for the machining operations agree with the points used for gaging the work. Unless the gaging is done from the same points as are used for locating the work in the jigs or fixtures, it will be found impossible to obtain a product that will be interchangeable.

— 0.004 inch for the outside and the root diameters, and — 0.002 inch for the pitch diameter.

Relation between Initial Clearance and Tolerance

There should be a certain relation between the initial clearance and the tolerance. It is evident that if there is a large initial clearance, considerable tolerances should also be permitted for the component parts, in order to reduce the manufacturing expense. For example, assume that there is an initial clearance between two parts of 0.005 inch. In that case, it would be entirely out of the question to demand a manufacturing tolerance of 0.001 inch on each of the component parts. It is more likely that in a case of this kind the initial clearance might be reduced to 0.003 inch, and that a manufacturing tolerance of 0.003 inch would be permissible on both of the component parts; or if an initial clearance of as much as 0.005 inch is desirable, it is likely that tolerances of 0.005 inch on each of the component parts are also permissible. In general, when the manufacturing tolerance is less than the initial clearance, it may be assumed that there is an error in judgment on the part of the designer. There are, of course, exceptions to this statement, but for general practice it will be found to be true.

Great difficulty is experienced with designs that do not provide for initial clearance in the original drawings. While the designer cannot and ought not to determine upon the tolerances at the time that the detail drawings for the component part of a mechanism are made, he should, as a general rule, determine upon the kinds of fit that he requires, which, in turn, makes it possible for him to dimension the drawings with the maximum metal dimensions, thus providing for the initial clearance at the time the design is made and the first or provisional detail drawings are made. For mechanisms that are assembled and taken apart various times during their use, more initial clearance is required than in the case of parts that go together in a permanent assembly, in which case little or no initial clearance is necessary. By reducing the initial clearance to a minimum amount, whenever this is possible, there is a chance for giving greater tolerances on the component parts, thus facilitating the machining operations, reducing the cost of manufacture, and increasing the rapidity at which the completed mechanisms may be made.

* * *

THE VALUE OF WASTE MATERIALS

The collection of waste material, an unimportant branch of industry before the war, has acquired great importance during the last two or three years. War has made the American manufacturer realize the value of waste materials. The trade in old metals has become an important factor in national economics, and much higher prices are being paid for them now than ever before. In view of this great increase in trade, the National Association of Waste Dealers has adopted a standard classification for old metals, as a help in making quotations. The gathering of old metal is being urged upon people all over the country as a patriotic duty; even the farmers in remote regions are collecting scrap iron and steel, and other scrap metals, and sending them to the centers where they can be used to the best advantage. This is another one of the many ways in which it is possible to aid in war work.

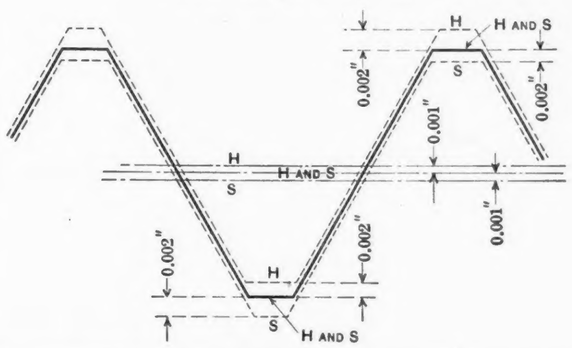
* * *

WHY SOME SHELLS HAVE THE LOWENHERZ THREAD

The reason why some shells and fuses made in this country have the Löwenherz thread instead of the U. S. standard form is not clear to many manufacturers and mechanics who have worked on shells and fuses for which the Löwenherz thread is specified. This thread has no mechanical advantages, so far as we know, as compared with the U. S. standard form, but it is applied to many of the shells intended for the French guns, especially when these shells are sent to the front without the fuses in place. The advantage is that the French fuses having the Löwenherz thread may be applied to shells that are made in the United States as well as to those that are made in France.

TOLERANCES FOR TAPPED HOLES AND SCREWS

U. S. FORM THREADS
20 to 50 Threads Per Inch
S = Screw; H = Hole



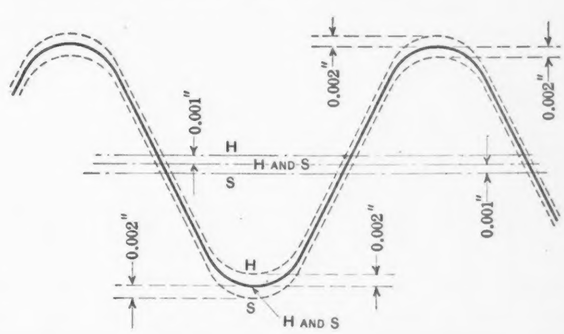
Tolerances for Screws

	Maximum	Minimum
Outside Diameter	Basic	Basic — 0.004
Root Diameter	Basic	Basic — 0.004
Pitch Diameter	Basic	Basic — 0.002

Tolerances for Tapped Holes

	Maximum	Minimum
Outside Diameter	Basic + 0.004	Basic
Root Diameter	Basic + 0.004	Basic
Pitch Diameter	Basic + 0.002	Basic

WHITWORTH THREADS
20 to 50 Threads Per Inch
S = Screw; H = Hole



Tolerances for Screws

	Maximum	Minimum
Outside Diameter	Basic	Basic — 0.004
Root Diameter	Basic	Basic — 0.004
Pitch Diameter	Basic	Basic — 0.002

Tolerances for Tapped Holes

	Maximum	Minimum
Outside Diameter	Basic + 0.004	Basic
Root Diameter	Basic + 0.004	Basic
Pitch Diameter	Basic + 0.002	Basic

Machinery

TORSIONAL STRESSES

BY F. W. SALMON[1]

The accompanying table was prepared for use in machine designing. It enables the designer to calculate quickly the torsional stresses for the various sections as given in the table. The condensed formulas are briefly set forth at the top of the table for calculating the torsional stresses of solid shafts of circular cross-section. Then follows a table of torsional moments at a fiber stress of 1000 pounds per square inch for various sizes of shafts. This table facilitates convenient reading of the slide-rule in making calculations. Formulas for other than circular sections are then given. The formula for the polar moments of inertia from Reuleaux's "Constructor" is given at the bottom of the table.

With the aid of this table and the use of a slide-rule, the torsional resistance moment can be quickly calculated for almost any form and proportion of section for any given load of permissible stress, with very little chance of material error.

[1]Address: Midland, Mich.

* * *

An employe who returned to his place of employment after hours was requested by his employer to do an errand; in doing so, he was killed in an accident. The Court of Appeals in New York has ruled that the errand was the cause of his death, and that services rendered in a spirit of helpful loyalty after closing time have the same legal status as services during employment hours.

TABLE FOR FINDING TORSIONAL STRESSES

TORSION

Stress in torsion in pounds per square inch on the outer fibers $= f_t = WR \div 0.196d^3$ for a round shaft, when $d =$ diameter in inches, and $R =$ radius in inches at which the torsional load W in pounds acts.

$$d = \sqrt{\frac{5.1WR}{f_t}} \qquad f_t = \frac{WR}{0.196d^3} \qquad W = \frac{f_t 0.196d^3}{R}$$

Resisting moment $= WR = f_t \times 0.196 \times d^3$

$f_t = 1000$ pounds per square inch

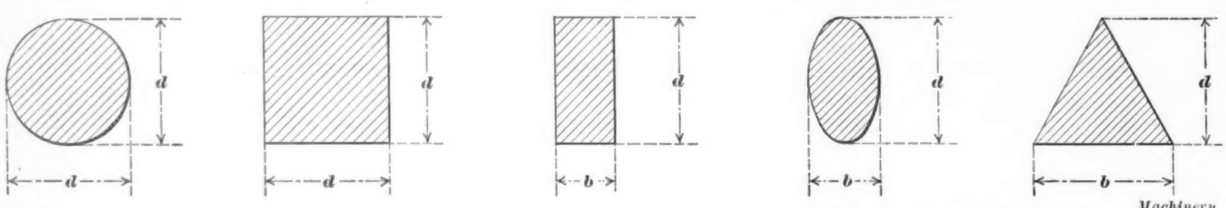
d	½	¾	1	1½	2	2½	3	4	5	6	7	8	9	10	12
WR	24.5	82.5	196	660	1568	3060	5280	12,530	24,500	42,300	67,200	100,000	143,000	196,000	339,000

Relative Torsional Stress of Sections of Equal Sectional Area

Circle	1.00	Rectangle, with sides in ratio $n : 1$; $(n > 1)$...	$\sqrt{\frac{2}{n + 1/n}} \times 0.886$
Square	0.886	Ellipse, with axis in ratio $n : 1$; $(n < 1)$...	$\sqrt{n}$

Some authors give relative torsional stress of squares and rectangles as 0.738 instead of 0.886. Merriman gives the relative torsional stress as varying from 0.833 to 1.000.

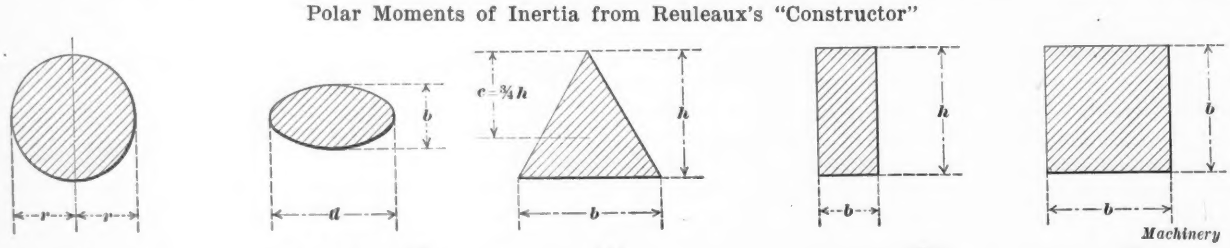
Ratio of Torsional Resistance to a Solid Circle Assumed as 1.00



Torsional resistance of square = torsional resistance of circle × 1.273

Ratio of $\frac{b}{d}$	⅛	¼	⅜	½	⅝	¾	⅞	1.00
Rectangle	0.0270	0.1080	0.2345	0.393	0.595	0.806	1.000	1.273
Ellipse	0.0157	0.0625	0.1400	0.250	0.387	0.568	0.767	1.000
Triangle (from Reuleaux)................	0.0270	0.0530	0.0795	0.106	0.133	0.159	0.186	0.212

Polar Moments of Inertia from Reuleaux's "Constructor"



$$I_1 = \frac{\pi}{2}r^4 \qquad J = \frac{\pi}{4}ba^3\left(1 + \frac{b^2}{a^2}\right) \qquad J = \frac{bh^3}{3b} \qquad J = 1/3\,\frac{b^3h^3}{b^2 + h^2} \qquad J = \frac{b^4}{6}$$

Stress in most distant fibers from torsion, using the notation above,

$f_t = WR\frac{c}{J}$; $WR = \frac{f_tJ}{c}$, in which $c =$ radius of most distant fibers.

SHELL BASE-COVER ASSEMBLING DIE AND PRESS

BY P. H. WHITE[1]

The general process of shell manufacture has become fairly well standardized in the various plants throughout the country, and while the different operations may vary somewhat

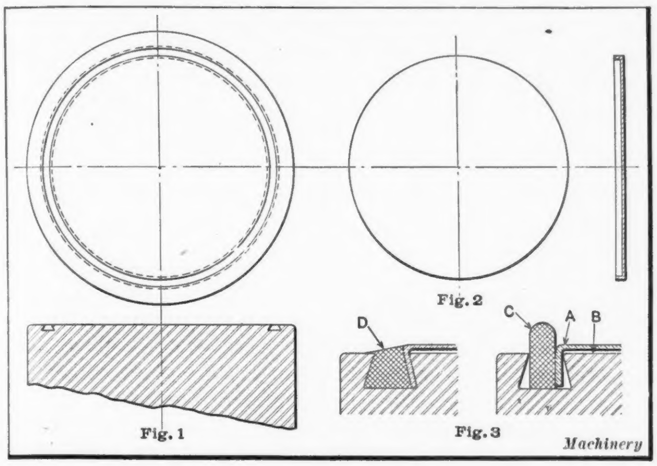


Fig. 1. Section of U. S. Eight-inch Shell showing Base-cover Groove. Fig. 2. Base Cover of U. S. Eight-inch Shell. Fig. 3. Enlarged Section showing Base Cover in Place

in different plants, the general methods are much the same, and have been so often described as to be quite familiar to all who are interested. There are, however, certain tools and fixtures which have been developed, that may be of interest to those engaged in other lines of manufacture. This article describes a die and press developed by the Root & Van Dervoort Engineering Co., East Moline, Ill., for the purpose of assembling the base covers on U. S. eight-inch shells. To those who are not familiar with shell manufacture, Figs. 1, 2, and 3 will illustrate this detail quite clearly. Fig. 1 is a plan and sectional view of the base of the shell, showing the base-cover groove. This groove is simply an annular dovetailed channel cut in the base of the shell near the edge.

Fig. 2 shows the base cover, which is a thin flanged copper plate that covers the portion of the base inside the annular groove. A thin disk of sheet lead is placed between the shell and the copper base cover. Fig. 3 is an enlarged section showing how the base cover *A* is held in place. The lead disk *B* is placed in the base cover, after which they are both placed over the base of the shell, the flange of the cover extending down into the groove. A strip of soft lead calking wire *C* is now wound around the groove outside the flange on the base cover. The shell next goes to the assembling press where the action of a special die, forces the calking wire down into the dovetailed groove, pressing the copper flange against the inner wall, and completely filling the groove. The appearance at the end of this operation is shown at *D*.

Fig. 4 shows the construction of the die. It consists of a steel cylinder *E* into which fits the steel plunger *F*. The plunger is held out by the action of three coil springs *G*, its travel being limited by the fillister-head screws *H*. The swing-bolt *I* is fastened to the die by means of the bushing nut *J*. This bolt screws into the suspension ring *K* which slides on the tie-rod of the press. Vertical adjustment of the die is accomplished by screwing the swing-bolt into the suspension ring and locking it by means of the lock-nut *L*.

The complete press with a shell in place is shown in Fig. 5. It consists of a base casting *M* with a heavy bracket at each end. A tie-rod passing through the upper end of the brackets serves to stiffen them, as well as to support the die. Two V-blocks are cast integral with the base casting, and serve to locate the shell in the press. Underneath the base is fastened the bracket *N* to which is bolted the air cylinder *O*. The plunger of the air cylinder connects with lever *P* which is fulcrumed at *Q*, thus transmitting its motion to plunger *R* which, in turn, operates the die. An opening through the front of the base casting guides the plunger and keeps it parallel, while the swinging link *S* allows lever *P* to accommodate itself to the motion of the plunger.

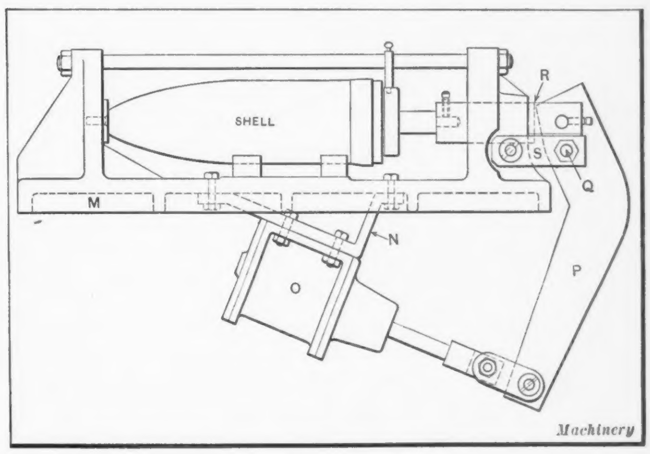


Fig. 5. Press and Die with Shell in Place

The operation of press and die is as follows: The shell with the base cover and the calking lead in place is rolled onto the vees of the press. The die is moved so that the face of the plunger rests against the base cover, after which air at a pressure of 100 pounds per square inch is admitted to the air cylinder; the plunger moves forward, giving motion to lever *P* which, in turn, transmits motion to plunger *R*. As *R* moves forward against the die, it causes cylinder *E*, Fig. 4, to telescope plunger *F* against the action of the springs *G*. This motion forces the lead into the groove. The plunger of the die prevents the lead from flowing back over the base cover, at the same time holding the cover tightly against the base of the shell. The slight bevel on the face of the die tends to force the lead in against the plunger rather than to allow it to flow outward before filling the groove.

The air cylinder used is 8 inches inside diameter, while lever *P*, Fig. 5, has arms 22 and 2 9/16 inches long. With air at 100 pounds per square inch, the pressure exerted on the die amounts to approximately 42,700 pounds. Sections sawed from sample shells have shown the base covers to be tightly seated, with the lead completely filling the groove.

* * *

In urging the use of gas as a fuel, a Paris journal points out that a thousand pounds of coal distilled in a gas retort equals more than 1200 pounds burned in a domestic stove; besides, it produces 500 pounds of coke, 7.1 pounds of benzol, 9 pounds of sulphate of ammonia, 10 pounds of heavy oils, and 1 pound of phenol.

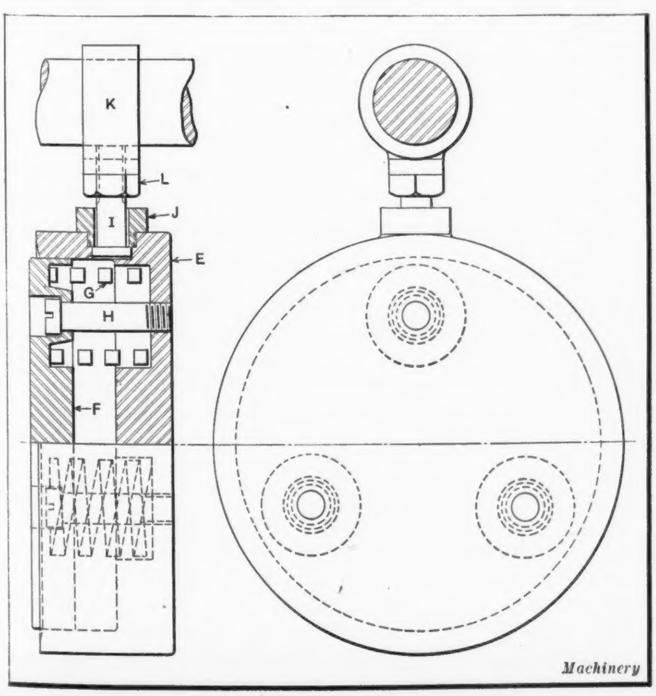


Fig. 4. Die for forcing Lead Calking Wire into Groove

[1]Address: 611 20th St., Moline, Ill.

FAILURE TO COMPLY WITH COMPENSATION ACTS

BY CHESLA C. SHERLOCK[1]

One of the questions that employers are continually asking is: What effect does the rejection of the workmen's compensation acts have on the right of the employe to bring an action for damages? This question can be correctly answered only by considering the results of the rejection of the acts by both the employer and the employe.

The compensation acts are voluntary for the most part, because the constitution makes it impossible for the state to impose them arbitrarily upon industry. It has been necessary, therefore, to make them so attractive to both employers and employes that they will accept them rather than remain under the old common-law procedure. While there can be no doubt that the compensation acts afford much better relief to employers and employes alike, there are always some who do not take kindly to them and prefer, by inclination and temperament, to remain outside their provisions. Sometimes, no other course is open to them, so these men are continually perplexed, as well as those contemplating changing their attitude, as to the legal liability attaching in case a change is made.

If an employer rejects the workmen's compensation acts or fails to come under its provisions, the injured employe may bring an action for damages for the injuries sustained under the common law. The proceeding is precisely the same as it was prior to the enactment of the compensation laws, with the exception that the employer is deprived of his common-law defenses of assumption of risk, the fellow-servant rule, and contributory negligence, unless it is shown that the negligence was willful.

It should be remembered that while the employe has this tremendous advantage of depriving his employer of the common-law defenses, he cannot recover unless he can show that his injury was due to the negligence, in some manner, of the employer. This is about the only defense remaining to an employer who has elected to take his chances in the courts.

In an Illinois case, where the defending employer had elected not to be bound by the provisions of the Illinois act, the plaintiff had been employed as a shot firer in the defendant's mine and sustained injuries consisting of a broken upper and lower jaw and the loss of several teeth and pieces of bone. He was incapacitated for a period of nine weeks from work and had to pay a doctor's bill of $75. There was no doubt that the injured employe had been guilty of contributory negligence in regard to the accident causing the injury. Because of the employer's failure to come under the compensation act, it was impossible for him to offer this evidence in the trial in order to reduce the amount of damages that the employe might recover. The court permitted a recovery, $1029.16, holding that such an amount was not excessive.

Need of Careful Observance of Law

In another case, it was held that where an employer files a written rejection with the proper authorities such rejection is a negative election and that it does not constitute an election to accept the provisions of the act where it has not been withdrawn within sixty days after the first of the new year. This is purely a statutory point of procedure, but one that employers are constantly overlooking. They do not look well to the specific provisions of their own state act when electing to reject or accept the terms of the acts, and while this may seem trivial in dealing with legislation which has at heart the just and humanitarian application of equitable provisions, it is of vast importance if slighted.

Suppose, for instance, that an employer who has rejected the terms of the law, in writing, should determine to withdraw his rejection and come under the act. He applies for insurance in the manner indicated by his statute, either with a private corporation doing business in the state or with an employer's mutual company as permitted under the act, pays his premium, and directs his secretary to give the proper notice to the state authorities, but fails to post notices so that his employes may know of the change, which is a statutory requirement in most of the states. John Doe, a lathe operator, is injured a few days later, and in the course of a week dies from his injuries. The circumstances of the case were such that there was gross negligence on the part of the employer in maintaining the defective machine that John Doe was required to operate. While the employer regrets the accident and had no personal knowledge of the defective condition of the machine, he feels secure in the possession of his compensation insurance policy; a recovery of perhaps three thousand dollars would be made by the widow from the insurance company. But the widow does not ask for compensation. In fact, she refuses it when it is offered and files suit at common law for damages. The result is that the employer loses the sum of fifteen thousand dollars, which is the verdict of the jury.

Acceptance by Both Employe and Employer

In some of the states the provision is made in the acts that the employe has no right to reject or accept the act unless his employer has taken a similar action prior to the employe's action; that is, the employe cannot accept the act unless the employer has already accepted it. Other states, however, place the acceptance of the act upon a voluntary basis both as to the employer and the employe. In this respect, the Massachusetts act provides that "an employe shall be held to have waived his right of action at common law to recover damages for personal injuries if he shall not have given his employer, at the time of his contract of hire, notice in writing that he claimed such right, or, if the contract of hire was made before the employer became a subscriber, if the employe shall not have given the said notice within thirty days of notice of such subscription."

In speaking of this provision of the act, the Massachusetts court clearly sets out the rights and liabilities of employes in that state. It said: "This sentence is plain and definite. The employe is held to have waived his common-law right if he fails to give notice at the time of his contract of hire. This absolute and unequivocal provision is not made dependent upon any other condition or circumstance. It is not made to rest upon knowledge or notice to him of the fact that the employer is a subscriber. That it was not intended to be dependent upon such knowledge or notice is plain from the concluding clause, which in the event of the employer becoming a subscriber after the employment makes such waiver dependent upon notice. The expression of this condition in the one class of cases impliedly would exclude it from the other, even if the language were less plain. It seems clear beyond a doubt from these words that the notice is required to be given when the terms of the employment are fixed by the contract of hire."

It is well to remember that the compensation acts are considered a part of every contract of hire, by presumption of law, unless it is expressly stated in the contract that such is not the case. The compensation acts also curtail, in no small degree, the right of the employer to enter into contracts with his employes respecting the right to compensation. These conditions vary in the different states and it is well for employers to keep themselves constantly informed on the subject.

Effect of Compensation Laws on Common-law Defenses

The proposition of greatest interest to the employer, however, is as to the common-law defenses and their relation to the compensation acts. In the first place, the theory back of the statutes should ever be kept in mind in a consideration of these laws. It was held under the common law that the party to blame should always bear the burden of losses; locate the negligent party, whether he be employer or employe and then fasten the blame upon him. The law took little consideration of the ability to bear this burden. The compensation acts, however, are not grounded upon any such theory. Their theory is that the injury is the topic of supreme importance. Was there a man injured? Then that man should be compensated. The injured man had long contributed his skill and labor to the good of society and society should be made to bear the burden of this industrial loss just as society bears every other burden of production. The employer, hav-

[1]Address: Box 604, Des Moines, Iowa.

ing afforded the employe the means whereby he became incapacitated, should be charged with the loss, but the employer can shift the burden upon the consuming public by charging more for his product.

Under the common law the courts permitted the employer to avail himself of several defenses. It was permissible for an employer, for instance, to show that the employe was guilty of contributory negligence and thereby relieve himself of liability in the matter. This is not the case at the present time, where the employer has accepted the compensation acts. Employers contemplating a rejection of the compensation acts should keep in mind the fact that they are not even allowed to avail themselves of this defense even at common law, under the present legislation. The common-law defenses are absolutely abrogated forever. Under the common law, the employer was allowed to come into court and say that he knew that his machinery was defective, but the employe knew it also and continued to work. Because the employe continued to work, it might be presumed that he had agreed, impliedly of course, to assume the risk of working with the defective machinery and the employer would be relieved of liability. This is not true under the acts and it is not true if the employer has rejected the acts. The defense of assumption of risk is absolutely abrogated by the compensation acts in those states where such acts are in force.

It was also permissible, under the common law, for an employer to defend a suit upon the ground that the injured workman was injured by the negligence of a fellow-servant. The law held the theory that the master was not liable for or chargeable with the negligence of a servant. This doctrine of the fellow-servant rule is no longer in effect, no matter whether the employer has accepted or rejected the acts. It can be seen that a failure to comply with the compensation acts places the employer in precisely the same position that he was in under the common law, with the exception that the acts have disarmed him.

* * *

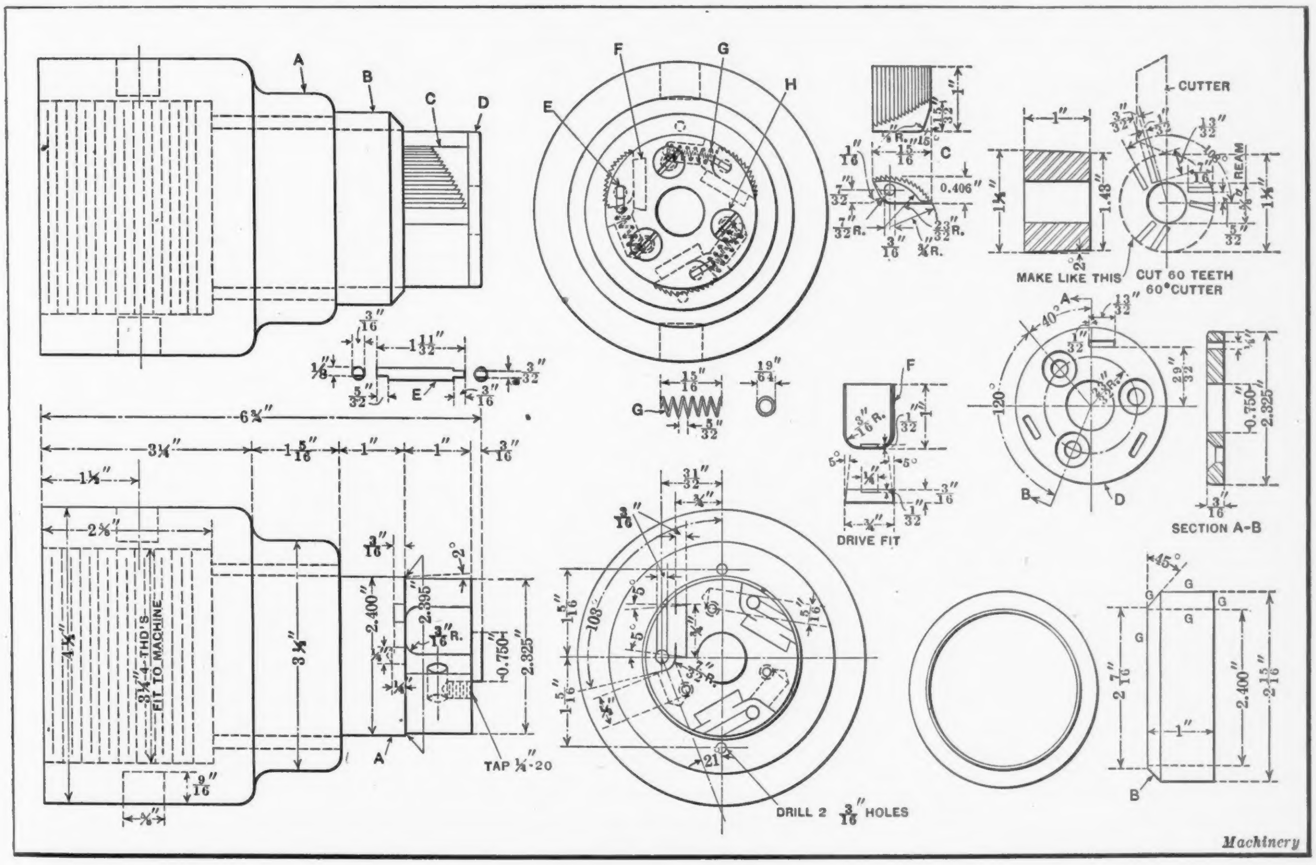
It has been found that one per cent of cadmium in zinc makes it unsuitable for the manufacture of high-class brass, especially for sheet brass used for drawing cartridge cases or other deep forms. On the other hand, it has been shown that less than one per cent has no injurious effect.

CHUCK FOR THREE-INCH SHRAPNEL SHELLS

BY DONALD A. BAKER[1]

Probably every concern making shrapnel has designed two or three chucking devices which have proved more or less successful. One concern found that a pivoted eccentric jaw type of chuck worked successfully on Russian shells, but when used on the U. S. three-inch shells chips got under the jaws. An effort was made to use rollers which passed up an inclined plane and wedged against the inside of the shell. This proved unsuccessful on account of the small gripping surface; as the walls of the shells were comparatively thin, they would bulge and allow the rolls to slip. This bulging and slipping action was continuous under heavy cuts. To overcome these defects, the chuck here shown was designed, and it has proved so successful that it is now being used in a shop turning out several thousand shells per day.

This chuck consists of a soft machinery steel body *A*, a hardened steel locating or centering ring *B*, jaws *C*, jaw retaining plate *D*, retaining pins *E* which are a drive fit in the jaws *C*, hardened backing plates *F* which take the thrust of the sliding jaws, springs *G* that keep the jaws out, and screws *H* that hold the jaw retaining plate. The hardened tool-steel jaws *C* slide on the hardened tool-steel backing plates *F* which are set into the soft machinery steel body of the chuck at such an angle that when the shell is slid over the jaws, and is located and centered by means of the collar *B*, the slightest turning of the shell to the right causes the jaws to slide up the incline and grip the shell on the inside. Slipping with this type of chuck is out of the question, as any increase in the pressure of the cutting tool only causes the jaws to grip the work more tightly. Yet when the cut is finished the work can be released instantly by turning the shell to the left with the hands.



Chuck for Three-inch Shrapnel Shells

* * *

Leaks in steam pipes that cannot be stopped by calking or plugging may be stopped with a cement made by mixing black oxide of manganese with enough raw linseed oil to form a thick paste. The steam pressure should be relieved in the pipe, but the pipe should be kept warm enough to dry the oil.

[1] Care of Service Engineering Co., 25 Church St., New York City.

MACHINERY

DESIGN — CONSTRUCTION — OPERATION

PUBLISHED MONTHLY

140-148 LAFAYETTE STREET, NEW YORK

England
51-52 Chancery Lane
London

Cable Addresses
Machinery, New York
Machtool, London

THE INDUSTRIAL PRESS
PUBLISHERS

ALEXANDER LUCHARS
PRESIDENT

MATTHEW J. O'NEILL
GENERAL MANAGER

ROBERT B. LUCHARS
SECRETARY

ERIK OBERG
EDITOR

ASSOCIATE EDITORS
FRANKLIN D. JONES
EDWARD K. HAMMOND
VICTOR BROOK

OCTOBER, 1918

CIRCULATION FOR SEPTEMBER, 1918, 25,500 COPIES

COORDINATION IN GOVERNMENT WORK

The leading article in this number of MACHINERY, "Developing a Gaging System for Small Arms and Heavy Ordnance," deals with a subject that at the present time is one of the most important in the mechanical field. It may be stated on very dependable authority that if all the principles laid down in this article and in the articles in the same series that are to follow had been thoroughly understood and acted upon in the designing and ordering of war materials, a vast amount of money could have been saved; and, what is more important, a great deal of time could have been gained in the completion of the gaging equipment and in the manufacture of the war material for which the gages were needed.

The designers of war materials have been working too independently of the manufacturers who were to supply the gages, tools, and fixtures, as well as the war materials themselves. As the article shows, it is practically impossible to work efficiently if the designers of the mechanism—be it a rifle, a heavy gun, or any other device—are located in one place, and the designers and builders of the tools and gages in other parts of the country. In the manufacture of mechanical devices it is necessary, if the highest degree of efficiency is to be obtained, that the complete control be under one roof. Given that condition, it is possible not only to produce a more satisfactory equipment in all its details, but also to cut down the expense and to gain time. At the beginning of the war, we did not realize the necessity for thoroughly coordinating the design of war materials with the manufacturing facilities of the country; but now this necessity is apparent.

* * *

ELIMINATING THE STOCK-ROOM

More and more are we coming to regard the up-to-date manufacturing plant as a huge machine, made up of an assembly of machines, for putting material through a series of operations. Less and less do we think of it as a place of sojourn, into which iron and steel parts may pass, to remain for an indefinite period. Stock-rooms, therefore, are coming to be looked upon as necessary evils, useful when, for some reason, the natural flow of material through the shop and its distribution to the customer are interrupted. A few years ago the usual procedure among manufacturers was to make parts and store them in the stock-room, whence they were drawn for assembly to fill orders. This plan is still followed, but it is becoming rarer in proportion as the principles of efficient management are becoming better understood.

Bearing in mind the new idea of maintaining a continued flow of material through a plant, some manufacturers make a point of keeping close together their right- and left-hand parts, as well as other parts needed for completing machines. In machining the parts of an airplane, for instance, since many right- and left-hand thread turnbuckles are needed, they are threaded on a two-spindle machine which cuts right- and left-hand threads simultaneously. In this way the operator threads as many of one kind as the other, thus making it possible for the product to flow through the plant in the even balance required. Similarly, in one up-to-date plant where harvesting machinery is built, the parts to be assembled into one unit are drilled simultaneously. They may be entirely dissimilar and require the use of entirely dissimilar fixtures on the multiple-spindle drilling machine, but the work is so distributed that the operator can run four spindles at once, and drill the different parts required for the unit, yet do it in such a way that no spindle remains idle much of the time.

The modern manufacturing plant is a place of transformation. Everything there should help toward transforming the material as rapidly as possible into the finished product. The quicker the transformation, the higher the efficiency and the greater the profit on the product.

* * *

THE MINIMUM WAGE

In rejecting the resolution declaring for a minimum wage, the National War Labor Board declared that in considering fair living wages it would be guided by individual or local conditions, to be ascertained in each case as it arises; and this is a far better method than the establishment of inflexible minimum wage rates affecting the whole country. The War Labor Board's resolution also announces a policy of opposition to unjust profits on the part of capital as well as to unreasonable demands on the part of labor. It declares that capital should receive "such reasonable revenues as will assure its use for the world's and the nation's cause"; and that labor should be assured wages sufficient for its "physical well-being and its physical and mental effectiveness, in a comfort reasonable in view of the exigencies of the war." The resolution was written by former President Taft and submitted jointly by Mr. Taft and Frank P. Walsh, the joint chairmen of the National War Labor Board. We hope that the efforts of the board to prevent industrial strife and disturbances at this time will be successful, and that both capital and labor will do all in their power to settle any differences in a peaceful manner, to prevent any cessation of work and interference with the all-important production of war materials.

* * *

AN EDUCATIONAL WAR SAVING

Lehigh University has decided to substitute, as a war measure, three-year courses for the four-year courses of the past. By shortening the summer vacation to one month, the university will be able to give its students the same course as formerly; but the student will gain a whole year of time, save a year's living expenses, and will be trained to steady and serious work similar to that expected of him in industrial engineering. The one-month vacation idea for colleges generally, thereby saving the time of the students, is well worth adoption not only as a war measure, but as a permanent feature.

The college term of thirty-four weeks a year for four years is a deplorable waste of time. It is out of harmony with the increased efficiency demand in industrial engineering and should not be tolerated in engineering schools. There is no reason why college professors and students should not be able to get along with four weeks' vacation in the summer when the majority of engineers get only two weeks' vacation, or none at all. Lehigh University is to be commended for initiative in the direction of greater efficiency in engineering education, and we hope that other engineering colleges will follow this example.

This is Our War—Yours and Mine

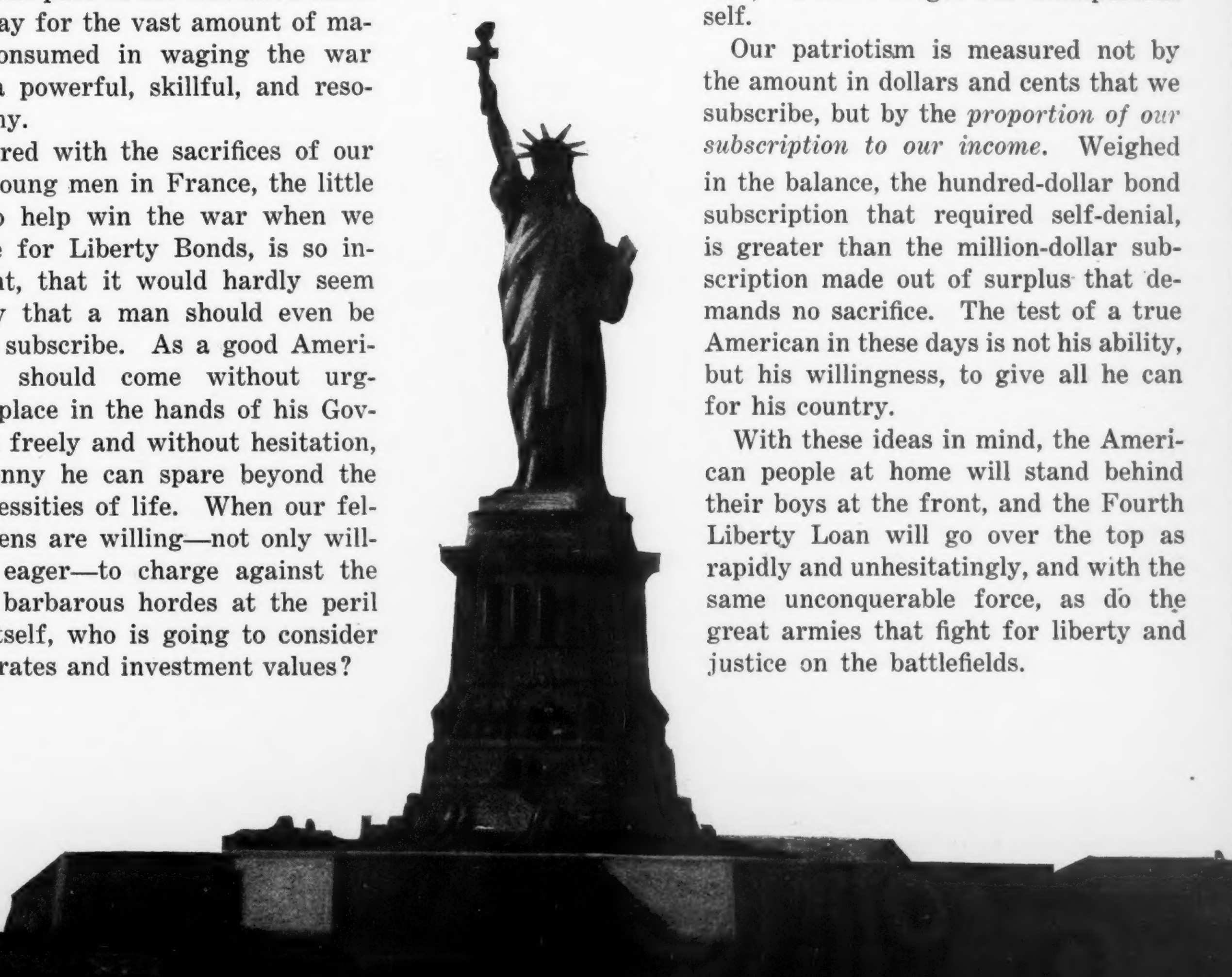
And the Success of the Fourth Liberty Loan Will Show That We Realize It

THIS is our war—ours to fight, ours to pay for, ours to win; and ours it will be to reap the benefits of peace and liberty when at last the menacing enemy is vanquished. It is our war—yours and mine; it is not a war of our Government, nor of rulers or commercial interests, nor of any kind of interests, but yours and mine. It is a war fought by the aroused American people as a protest and defense against militarism, Prussianism, and the return to medieval barbarism. It is a war fought that we may live in peace under the liberties and institutions built up in America.

In waging the war, sacrifices are required of the citizens of the United States. Some, because they are better fitted for that task, are asked to place themselves on the firing line, and to sacrifice, if need be, life itself. In comparison with what these men are asked to give, how little seems the sacrifice asked of us who stay at home. All that is required of us is that we labor industriously in the work of production and place at the disposal of our Government part of our increased earnings to pay for the vast amount of materials consumed in waging the war against a powerful, skillful, and resolute enemy.

Compared with the sacrifices of our valiant young men in France, the little we do to help win the war when we subscribe for Liberty Bonds, is so insignificant, that it would hardly seem necessary that a man should even be asked to subscribe. As a good American, he should come without urging and place in the hands of his Government, freely and without hesitation, every penny he can spare beyond the bare necessities of life. When our fellow citizens are willing—not only willing but eager—to charge against the enemy's barbarous hordes at the peril of life itself, who is going to consider interest rates and investment values?

It is a war fought that we may live in peace under the liberties and institutions built up in America.



The man or woman who is not willing to sacrifice all the small luxuries, and even a few of the apparent necessities of life, in order to do his or her part in helping along the vital enterprise in which we are engaged, has no right to refer to the valiant army in France as "our" army or to their victories as "our" victories. Only those who have done all in their power to achieve the great purpose of the American nation, can share any of the glory that attaches to the incomparable courage and indomitable will of our boys in France.

The campaign for the Fourth Liberty Loan is just launched, and the amount to be subscribed is double that asked for in the previous Liberty Loans. This means more effort, more will to accomplish. It means that each of us must double his subscription. It means that we must begin to learn to do without some of the things we considered necessities in the past. It means that we must begin to curtail, to eliminate many extravagances which characterize the American people as compared with all other nations. It means that until victory is won, we must forget our unimportant self.

Our patriotism is measured not by the amount in dollars and cents that we subscribe, but by the *proportion of our subscription to our income.* Weighed in the balance, the hundred-dollar bond subscription that required self-denial, is greater than the million-dollar subscription made out of surplus that demands no sacrifice. The test of a true American in these days is not his ability, but his willingness, to give all he can for his country.

With these ideas in mind, the American people at home will stand behind their boys at the front, and the Fourth Liberty Loan will go over the top as rapidly and unhesitatingly, and with the same unconquerable force, as do the great armies that fight for liberty and justice on the battlefields.

FUTURE DEVELOPMENT OF AUTOMATIC MACHINES

BY GEORGE O. GRIDLEY

General Manager, National Acme Co., Windsor, Vt.

THE development of automatic machinery in the future will proceed along the lines that have been fairly well defined by the new departures that the present war has made necessary. While in America automatic machines of various types were freely used previous to the war, the last four years have given a tremendous impetus to the employment of machines of this type; and in Europe the use of automatic machines has almost entirely revolutionized the methods used previous to the beginning of the war. It may be of interest to review briefly the immediate causes that have been responsible for this change, and also to analyze what the future holds with regard to the development of automatic machines and their increased use.

Effect of War on Use of Automatic Machinery in Europe

Generally speaking, most of the European nations had not been educated to the value of the extensive use of automatic metal-working machinery previous to the war. While some progressive firms here and there made use of a limited number of automatic machines, the majority of manufacturing concerns employed hand-operated machines and were able to do this profitably, because wages were low and the supply of labor plentiful. At the beginning of the war, however, a radical change took place, both with regard to wages and the supply of labor, and, furthermore, it became necessary for the national existence of some of the nations to greatly increase the production of all the available plants in order to meet the heavy demands for war materials. Hence, today, automatic machines are doing work in England, France, and Italy that no one ever thought of performing on machines of this type four years ago, and after the war this condition will continue for a number of reasons, chief among which are the high wages that will prevail abroad after the war, the lack of man-power, and the ever-increasing employment of women in machine shop work.

Influence of Entrance of Women into Machine Shops on Use of Automatic Machines

The entrance of women into machine shops has largely necessitated an increased use of automatic machines. In Europe, for example, it is safe to say that there are many times the number of automatic metal-working machines used today that were employed four years ago. Women are especially suited to operate automatic machines, because they need not be highly skilled for this work, and mechanical training and adaptation is not required except in a limited degree. Not only has the entrance of women into machine shops increased the employment of automatic machines at the present time, but their continued employment will force a further development in the design of automatic machines, so as to especially adapt them for being handled by comparatively unskilled and untrained help.

The single-operation automatic machine is, therefore, likely to be more highly developed in the future, and one of the great changes that we may look forward to is in the development of methods for transferring work from one single-operation automatic machine to another, yet insuring that the work will be held correctly for each machining operation. The improvements along these lines will probably be the most important that will take place in the field of automatic machinery for some years to come. While the development during the war has been rapid, it is reasonable to expect that the development in the years immediately following the war will be still more accelerated, because, at that time, there will be a greater opportunity to pay attention to details of this kind than there has been during the past few years. At the present time, production is the one great factor, and improvements have largely had to rest until a more opportune time.

Influence of High Wages and Need for Increased Production

Future developments in automatic machines will, however, not only be forced by the increased employment of women in machine shops, but also by the higher wages that will be prevalent after the war. While the present high wages may not become permanent either in this country or in Europe, the wages will never come back to the level at which they were previous to the war. Hence, it becomes necessary to devise machines and methods that will increase the production in proportion to the increase in wages. But even apart from the great increase in cost, due to the increase in wages, there will be a necessity for increased production, merely in order to supply the demand when the war is over. The man-power of all the fighting nations will have been so decreased, and the requirements for rehabilitation of the nations that have been at war will be so great, that only by an enormously increased production will manufacturers be able to meet the demands placed upon them. This increase in production can be accomplished only by the aid of highly developed automatic machinery, making it possible for the individual operator to multiply his production. With more work to be done than ever before, and a smaller number of workers available to perform the tasks allotted to them, there is no other solution than a material increase in the use of automatic machines and the elimination of the hand-operated machines for any purpose where this is possible.

Conclusions as to Future Developments

Summing up, therefore, it may be said without the slightest hesitation that automatic machinery will be used to an ever-increasing extent after the war, and that single-operation automatic machines especially will be more highly developed, the main reason for this being that women, having entered machine shop work, have come to stay. In addition, it should be mentioned that larger automatic machines than have ever been used in the past will also be developed, especially to handle forgings. These machines, of course, will not be wholly automatic, but will require that the work be set up by an operator, after which the machine will perform all the operations automatically. Strictly speaking, machines of this type should be termed "semi-automatic" machines. Instead of looking forward to a lull in the development of automatic machinery after the war, we may, therefore, look forward to a decided advance in both the design and production of these machines, as well as to an increase in their capacity.

* * *

COAL SAVING SUGGESTIONS

Just at this time, when the conservation of coal is an absolute necessity, every practical suggestion for such conservation should be of interest. Everyone knows that smoke issuing from boiler stacks represents unused heat units, but it is not generally realized that certain simple rules, if observed in the fire-room, will materially decrease this loss. The following suggestions are based on many years' experience of the Westinghouse Electric & Mfg. Co.'s combustion engineers:

(1) Prevent smoke by proper firing methods. (2) Use gages to indicate exactly the condition of the fire bed at all times. (3) Avoid loss due to unburned coal in the ash. (4) Don't waste exhaust steam, as this is wasting coal. (5) Don't permit the grates to clog. (6) Inspect the baffles in the boilers, as broken or leaky baffles raise the flue gas temperature and waste coal. (7) Install stokers. Hand firing is rapidly being recognized as an obsolete and wasteful method of firing. (8) Clean scale and soot from tubes. (9) All smoke flues should be as short and straight as possible. Flues should also be made air-tight, and all joints and connections should be well fitted, calked, and riveted. Use asbestos gaskets on clean-out doors. (10) The size of coal has much to do with the capacity and efficiency of boilers. In general, the air pressure penetrates the fuel bed formed by coarse coal easier than that formed by finer coal, resulting in a disturbance of the best furnace conditions.

Roller Bearings *for* Machine Shop Equipment–1

Fourth of a Series of Articles on Bearings

By Edward K. Hammond
Associate Editor of MACHINERY

ROLLER bearings are able to give a higher degree of efficiency in the transmission of power than it is possible to attain where plain bearings are used, owing to the fact that in place of surface contact and rubbing friction of the plain bearing, there is line contact and rolling friction in a roller bearing. Several types of roller bearings are finding application in the construction of machine tools, countershafts, lineshaft hangers, and other classes of equipment used in the machine shop. In order to obtain successful results from the application of roller bearings, the necessary precautions must be observed in mounting the bearings and providing for their lubrication; care must also be taken to protect the rollers and races from rust or damage resulting from the entrance of abrasive dust and other foreign matter into the bearings. It is proposed in the following discussion to present information concerning the uses which different well-known machine tool builders are making of roller bearings, and this explanation of methods of mounting bearings of this type which have demonstrated their practicability under actual working conditions, will doubtless prove of value in enabling other machine tool builders to apply similar methods in the construction of their own product.

Most engineers will concede that, theoretically, the substitution of roller bearings for plain bearings should result in making an improvement in transmission efficiency. But some of them who have not had experience with the use of properly designed roller bearings made of the right kind of steel and manufactured in a way to produce the required degree of accuracy, are skeptical about the merits of this type of bearing. In selecting any form of mechanical equipment, it is necessary for the engineer to decide upon the use of that type which is best adapted for the conditions of service which have to be fulfilled in the particular case that is under consideration. This is true in the case of roller bearings, because while they are especially well suited for certain lines of work, there are other cases where roller bearings will fail to give satisfactory results, owing to their unsuitability for that particular form of service. It is an almost universal experience that where high-grade roller bearings mounted in properly designed housings are used under conditions of service for which they are adapted, the results obtained will be highly satisfactory.

Selection of Bearings and Design of Mountings

Two points of vital importance in the application of roller bearings are to first select a type of bearing which is adapted for the conditions of service under which it is to be used, and then to mount this bearing in a suitable form of housing. There are on the market a number of different types of roller bearings which are made in a great variety of sizes. Expert advice is often a matter of considerable importance in making a proper selection of a bearing of the desired capacity, and which is otherwise adapted for specified conditions of service. Unless the engineer has had considerable experience in the use of roller bearings, it will usually be desirable for him to submit to the manufacturer from whom roller bearings are to be purchased detailed information concerning conditions of service under which they are to operate. With these data at his disposal, the roller bearing manufacturer will be in a position to select the particular type of bearing which his intimate experience in this branch of engineering tells him is best suited for the work.

The Standard Roller Bearing Co., of Philadelphia, Pa., in common with other manufacturers of anti-friction bearings, states that information should be given concerning the total load which each bearing is required to carry, the number of revolutions per minute at which it is to run, the diameter of the shaft, and, in case the available space which the bearing may occupy is limited, information concerning the amount of space which is available. With such information at his disposal, a roller bearing manufacturer is able to select the best type of bearing for the given conditions of service. Most manufacturers of anti-friction bearings appreciate the importance of this service rendered to their customers, and they maintain engineering service departments which are able to give expert assistance in the selection of bearings and the design of mountings to meet various requirements. There are so many factors to be taken into account in properly designing mountings for anti-friction bearings, that it is also advisable for the customer to submit a drawing of the equipment in which the bearings are to be used, to give a supplementary description of any unusual conditions which might affect the operation of the bearing.

Attention is also called to the absolute necessity of having machine members which are to be carried by roller bearings mounted in true alignment; otherwise, the full efficiency of the bearings cannot be secured because of failure of the rollers and raceways to operate with the theoretical line contact. In cases where this true alignment is not secured, the bearings are likely to be rapidly destroyed, in addition to their failure to operate with the maximum degree of efficiency. Where it is not possible to machine the housings in true alignment, self-aligning housings should be used. The principal differ-

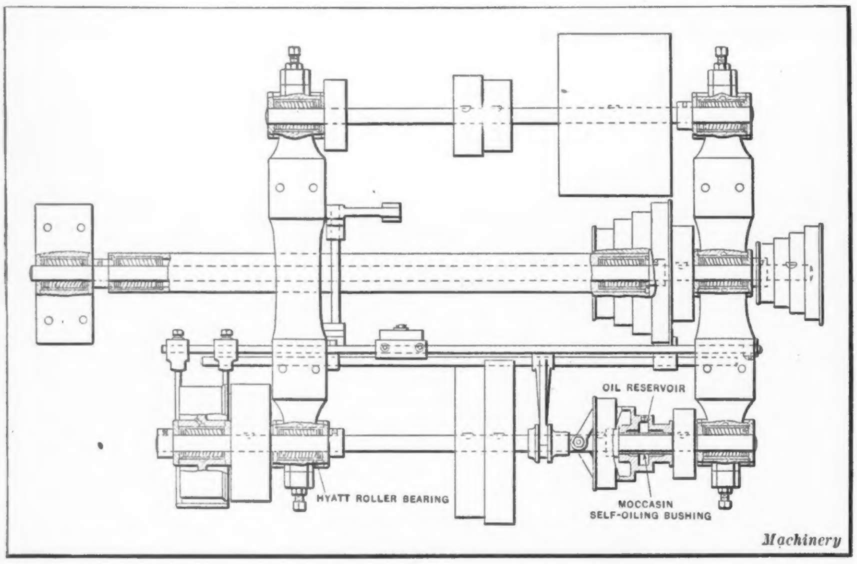


Fig. 1. High-speed Countershaft for driving Grinding Machine. Here Roller Bearings are of Particular Value in reducing Power Losses and Wear

ence between the operation of a ball bearing and of a roller bearing is that in the first case there is point contact, while in the second case there is line contact. On this account, roller bearings are adapted for carrying heavier loads than ball bearings, although no definite rule can be adhered to in this connection. Generally speaking, ball bearings are adapted for operation at higher speeds than roller bearings. In any case, a careful consideration of all conditions under which the bearings operate will be the means of reaching a decision as to whether a ball or a roller bearing is best suited for the particular installation that the engineer has in mind.

Installation of Roller Bearings

Where a radial load is carried by a roller bearing, and a thrust load by a ball bearing on the same shaft, it is essential for the two bearings to be in accurate alignment with each other; otherwise, a heavy strain will be placed on them. Both bearings should also be placed as close to the load as possible, because when this is not done, any deflection of the shaft reduces the efficiency of the bearings and may cause trouble. Where there is danger of the shaft being sprung out of alignment, some form of equalizing device should be used.

Improvement in Efficiency through Use of Roller Bearings

By installing roller bearings in place of plain bearings, a substantial increase in transmission efficiency is secured, owing to the substitution of rolling friction for the sliding friction of plain bearings. The actual saving of power resulting from the application of roller bearings in machine shop equipment will naturally vary considerably, according to the class of equipment and the conditions of service under which the bearings are required to operate. Probably the best way to give an idea of savings which can be effected in this way is to cite various instances where actual tests have been conducted for the purpose of determining definitely the relative efficiency of plain bearings and roller bearings in specific classes of service. A test made by L. P. Alford and C. E. Blackwell of the United Shoe Machinery Co. at Winchester, Mass., showed the comparison between plain bearings and Hyatt roller bearings on a lineshaft driving eighty-eight machine tools. Average results showed a saving of 16.8 per cent in power when completely loaded and 64.9 per cent power saving at no load.

Another test was conducted at the plant of the Hyatt Roller Bearing Co., in Newark, N. J., to determine the improvement in efficiency through the substitution of roller bearings for plain bearings in two-ton trolleys running on I-beams. In two types of trolleys which were tested with plain and Hyatt roller bearings, respectively, the improved efficiency through substitution of the roller bearings was 47 and 65 per cent.

Tests conducted by the Royersford Foundry & Machine Co., Inc., 54 N. 5th St., Philadelphia, Pa., have shown that the average saving in power required to overcome frictional resistance in lineshaft hanger bearings, where "Sells" roller bearings, which this company manufactures, are substituted for babbitted or cast-iron bearings, ranges from 25 to 50 per cent, and in some cases the saving is even greater. "Sells" roller bearings are sold under a guarantee that they will effect an improvement of at least 25 per cent in the transmission efficiency, at no load, over the transmission efficiency of the plain bearings for which they are substituted.

A further example of the improvement of efficiency resulting from the substitution of roller bearings for plain bearings is seen in the case of rolling mills built by the Standard Machinery Co., of Auburn, R. I., for use in the production of cold-rolled steel. These mills are equipped with roller bearings on the journals that support the rolls, and it will be apparent that the conditions of operation are very severe, owing to the heavy pressures to which the bearings are subjected. It is stated that the saving of power resulting from the substitution of roller bearings for plain bearings has ranged from 50 to 60 per cent, and that a further important advantage is secured through the possibility of running the rolls continuously without danger of overheating, as was the case where the journals were supported by plain bearings. The use of roller bearings enables the rolling mills to be operated twice as fast with rather less than 50 per cent of the consumption of power which was necessary where plain bearings were employed.

Roller Bearings in Countershafts and Lineshaft Hangers

When used in countershafts and lineshaft hangers, roller bearings are the means of effecting a substantial saving in the amount of power consumed in overcoming useless frictional resistance. Here the full benefit of anti-friction bearings is secured without the possible limitation of their not being adapted for maintaining an absolutely tight fit. In the bearings of a countershaft or lineshaft hanger, efficiency in the transmission of power, elimination of danger of the bearings giving trouble from lack of proper lubrication, and the possibility of providing the bearings with a supply of lubricant that is adequate for a considerable period of time without further attention, are points which make roller bearings especially well suited for this class of service. Some man-

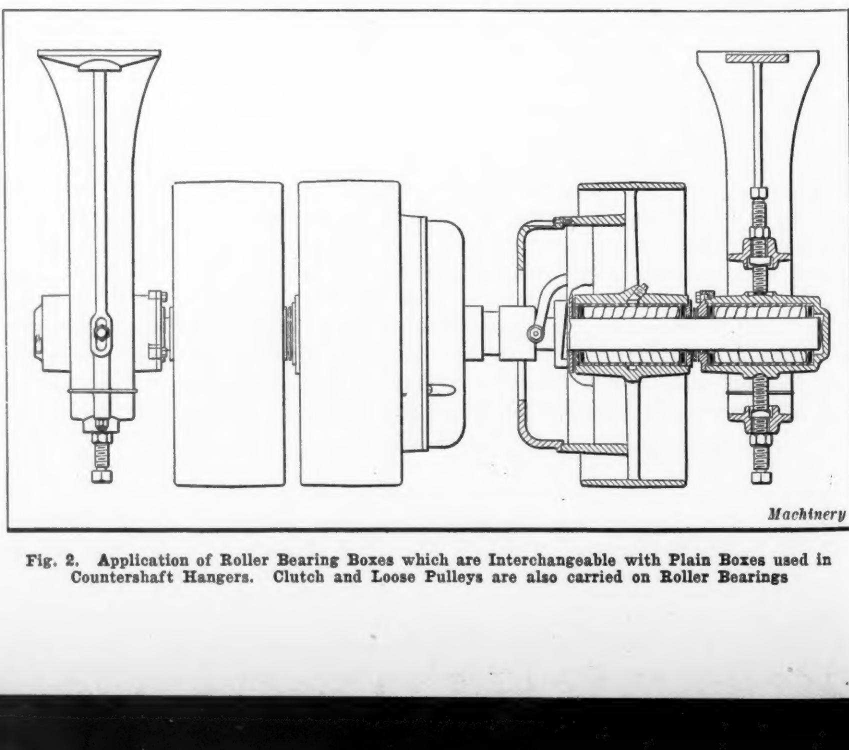


Fig. 2. Application of Roller Bearing Boxes which are Interchangeable with Plain Boxes used in Countershaft Hangers. Clutch and Loose Pulleys are also carried on Roller Bearings

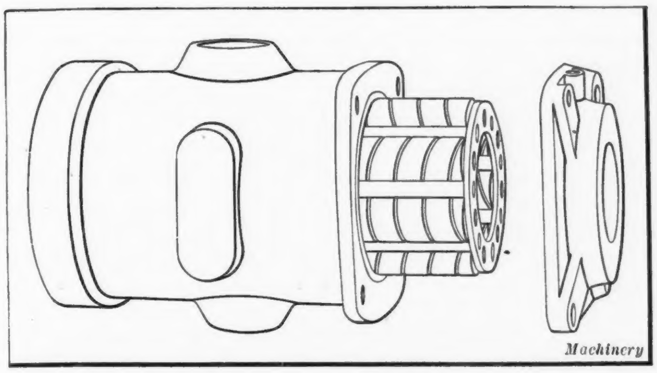


Fig. 3. Roller Bearing Box which is Interchangeable with Plain Box in Universal Type of Shaft Hanger

ufacturers express the opinion that roller bearings are better suited for this purpose than other types of anti-friction bearings, because they are not as susceptible to injury when improperly lubricated. Failure to lubricate the bearings of countershafts and lineshaft hangers is probably more frequent than in other locations in the shop, owing to the inaccessibility of these two classes of equipments. Fig. 1 shows a countershaft built for driving grinding machines manufactured by the Webster & Perks Tool Co., of Springfield, Ohio. It will be seen that all of the shafts are supported in Hyatt roller bearings, with the exception of the cone pulley that is furnished with a Moccasin self-oiling bushing which is provided with a supply of oil contained in a reservoir inside the pulley.

Fig. 2 shows another typical example of the way Hyatt roller bearings are applied in countershafts. It will be seen that the countershaft is supported by two hangers, each of which is equipped with a roller bearing box of similar design to the lineshaft box shown in Fig. 4, except that it does not have to be split. This countershaft is equipped with two clutch pulleys and one tight pulley, one of the clutch pulleys being used for reversing the direction of rotation of the machine tool which is driven by the countershaft. It will be seen that the clutch pulleys are also provided with Hyatt roller bearings and that both the rollers in the hanger bearings and the clutch pulley bearings run directly in contact with the shaft, thus affording an inexpensive method of installation.

Fig. 4 shows a lineshaft bearing box equipped with a Hyatt roller bearing; this box is suitable for mounting in a standard type of lineshaft hanger which is extensively used in machine shops throughout the country. The assembled hanger and bearing are shown in Fig. 4. The distinctive feature of a Hyatt bearing for this purpose is that it operates directly on the lineshaft, allowing the shaft to float freely and making it possible to place the bearing and hanger in any desired position along the shaft. Another important point is that the bearing box and roller assembly are split, which makes it possible to install or remove the lineshaft bearing without disturbing any pulleys or couplings. It is claimed that the length of this bearing is so proportioned that the shaft will not show any signs of wear, through action of the rollers, after years of continuous service. The bearing box is made of cast iron and is protected by means of a cold-rolled steel lining that makes a hard smooth track on which the rollers run with very little frictional resistance. It will be apparent that the hanger is furnished with the usual arrangement of adjusting screws *A* which enable the bearing box to be set in exactly the desired position to obtain accurate alignment of the shafting. Locknuts are furnished on these adjusting screws in order to maintain them in the desired positions. Pivoted oil-hole covers *B* provide for excluding dust and other foreign matter from the oil-holes, and when it is desired to supply oil to the bearing these covers may be easily raised. At *C* there is a threaded drain plug which is taken out when it is desired to clean the bearing by flushing it with kerosene. Each end of the bearing box is provided with a grease groove and oil wiper *D* to facilitate lubrication.

"Sells" Roller Bearings for Countershafts and Lineshafts

The "Sells" roller bearing is made by the Royersford Foundry & Machine Co., Inc., 54 N. 5th St., Philadelphia, Pa., to meet the special requirements of service demanded of bearings used in countershafts and lineshaft hangers; a heavy-duty type of "Sells" roller bearing is also made to meet the exceptionally severe conditions of service which are encountered by the bearings which carry jack-shafts. It often happens that in a plant where trouble has been experienced in the operation of plain bearings a decision is reached to substitute some form of anti-friction bearing, and to facilitate this work of substitution, the "Sells" roller bearings are made with all parts split so that they can be assembled over a shaft at any point without requiring the shaft to be taken down. These bearings are also made in such sizes that they may be set up in practically any standard form of lineshaft hanger, which is another important feature in facilitating the work of substitution. Bearings of this type are made to fit shafts from 15/16 inch to 7 inches in diameter, inclusive, and by varying the thickness of a steel bushing which is placed around the shaft to form a track on which the rollers run, each bearing may be adapted for carrying three standard sizes of shafts. Drop and post hangers and pillow blocks, with universal adjustment, are made to carry the bearing boxes. These boxes can also be used in most standard types of hangers.

Having made this preliminary statement concerning features of the "Sells" roller bearing, we are ready to enter upon a detailed description of features of its design. In the first place, attention is called to the fact that there is no possibility of wearing the shaft because the rollers run on a hardened steel bushing, which is placed around the shaft, and this bushing is carefully ground so that the accurately ground rollers have a perfectly true path on which to roll. In this way, a high degree of transmission efficiency is assured and it is stated by the makers of this bearing that reduction of friction where "Sells" roller bearings are substituted for plain bearings ranges from 25 to 50 per cent and sometimes considerably higher. The bearings are sold on a guarantee that they will show a saving in power at no load of at least 25 per cent over that consumed in operating shafting supported in babbitted or cast-iron bearings. The bearing consists of four parts, namely: (1) The split bushing made of hardened high-carbon steel, which surrounds the shaft and forms a track on which the rollers run; (2) two split collars which are counterbored to fit over the ends of the split bushing; these collars are furnished with set-screws to provide for tightening them up and securing the bushing firmly in place on the shaft; (3) the split roller structure which consists of cage rings held rigidly together by stay-rods in such a way that the structure retains the hardened and ground rollers and holds them in alignment with the shaft; (4) the split box which is provided with an accurately ground race-

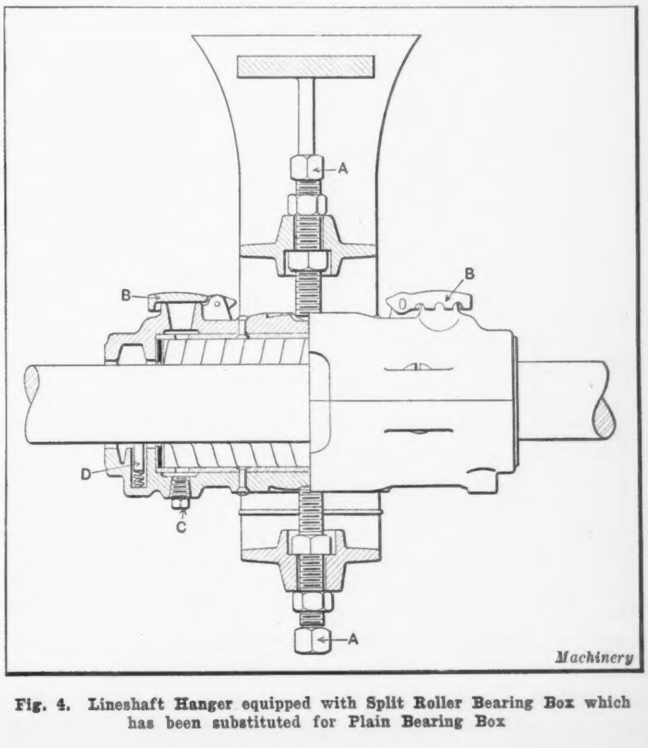


Fig. 4. Lineshaft Hanger equipped with Split Roller Bearing Box which has been substituted for Plain Bearing Box

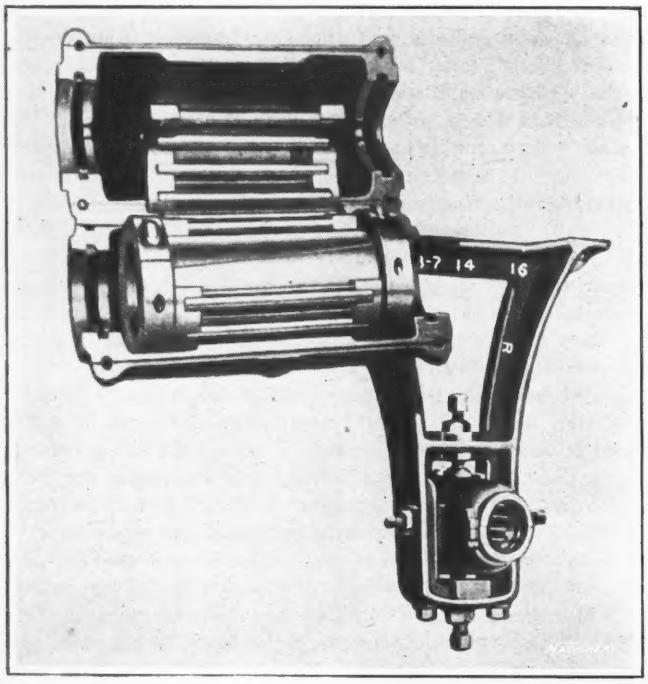


Fig. 5. Split Roller Bearing Box and Type of Hanger in which it is mounted

way for the rollers; this box is also furnished with reservoirs to carry a supply of lubricant for the bearing and felt packing rings at each end, which prevents the escape of lubricant and excludes grit and other foreign matter from the bearing.

Probably the best idea of the design of this bearing and the way in which it is assembled on a shaft will be gathered by reference to Fig. 6. The split bushing *A* which surrounds the shaft is put in place so that it will be located exactly in the center of the box, after which collars *B* are pushed over the ends of bushing *A* and the set-screws in these collars are then tightened so that the bushing and collars are securely held against lateral movement. The lower half *C* of the bearing

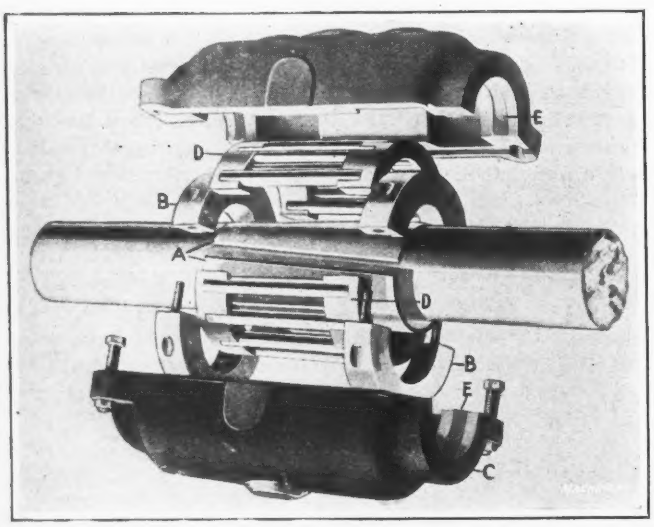


Fig. 6. Close View illustrating Details of Roller Bearing shown in Fig. 5

box is next placed in position, after which the two halves of the roller structure *D* are placed over the bushing *A* and between the collars *B*. Then a liberal supply of "rollerine," which is a special semi-liquid lubricant for use in roller bearings, is put between the rollers inside the collars before placing the upper half of the box in position. When the upper half of the box is in place, care must be taken to have the two halves fitted exactly as marked, and after this has been done, they are bolted together. Care is taken not to tighten the hanger adjusting screws against the box but simply to screw them down by hand until they touch the box, the object being not to spring the box and cause the rollers to bind. Shaft collars should be used at the outside end of boxes at intervals along the shaft, although they need not be used in connection with every box.

It will be seen that the box is designed with a felt packing *E* at each end, which serves the double purpose of preventing the escape of lubricant from the box and the admission of grit which would cause the bearing to be rapidly worn out. The bearing is of the so-called "floating" type and is constructed in such a way that none of the moving parts come into contact with the stationary box except the rollers which run on a raceway ground on the inside of the box. The shaft is left free to float, thus having provision to adapt itself for slight variations in alignment, etc. Mention has already been made of the saving in power consumption which is effected through the substitution of "Sells" roller bearings in place of plain babbitted or cast-iron bearings, but there is another important saving which is often a matter of considerable importance. This is the prevention of unnecessary wear and tear on belts. It has been estimated that in the case of a shaft carried in roller bearings, only one-eighth as much belt pull is required to start the shaft rotating as that which is necessary in the case of a similar shaft carried in plain bearings. As regards the amount of wear in the bearings, themselves, it will be of in-

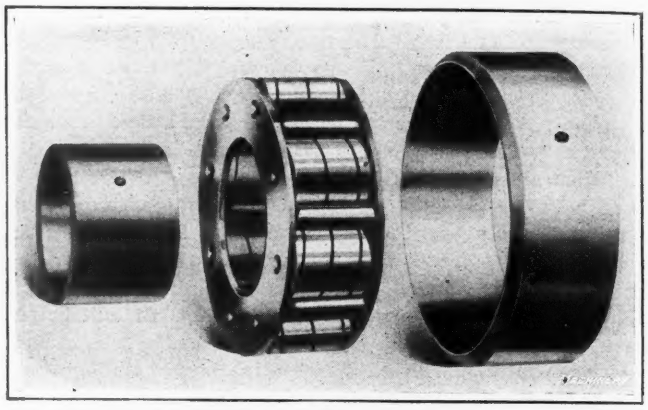


Fig. 7. General View of Hyatt Roller Bearing for Machine Tools

terest to note that after eighteen months' test of a bearing used under severe conditions of service, the rollers were found to be worn less than 0.0005 inch and that the box showed practically no wear; there was only a few thousandths inch wear on the bushing around the shaft.

All parts of the bearing are made interchangeable, so that in the case of accident or where the amount of wear has reached a point making replacement necessary, any standard parts can be assembled into the bearing without requiring hand fitting. Experience has shown that the amount of friction which exists in a roller bearing increases as the load on the bearing is increased, and that this may finally reach a condition of frictional resistance that will result in destruction of the bearing. For this reason, care must be taken in the selection of roller bearings to be sure that they are of the proper size and load-carrying capacity for the service which is required of them. Lubrication is also a matter of great importance, and to assure satisfactory operation of these bearings, the Royersford Foundry & Machine Co. has developed a special

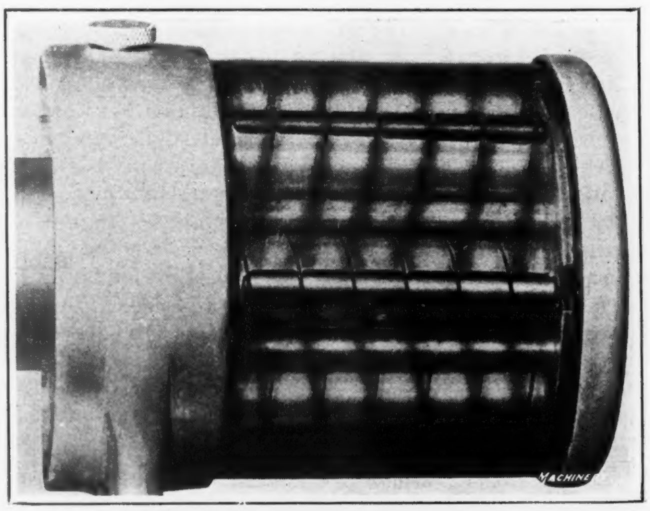


Fig. 8. Special Machine demonstrating Uniform Distribution of Lubricant by Spiral Grooves in Hyatt Roller Bearings

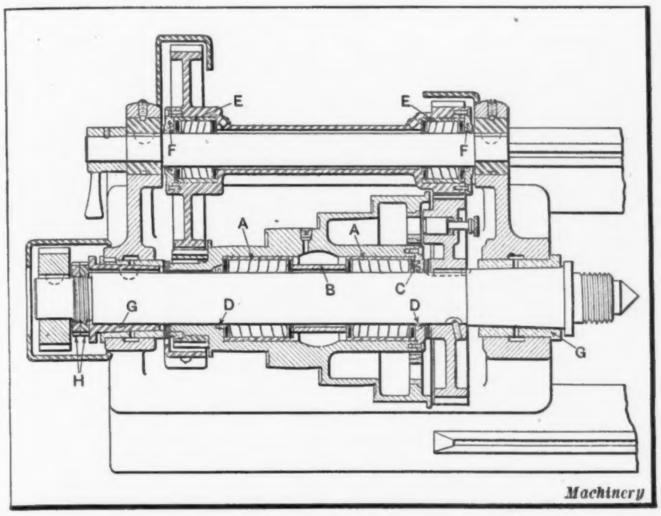


Fig. 9. Lathe Head with Spindle mounted in Plain Adjustable Bronze Boxes. Self-lubricating Feature, and Cone-pulley and Back-gear Shaft carried by Roller Bearings to reduce Friction, give Durability and eliminate Lubrication Troubles

semi-liquid grease of about the consistency of vaseline. This lubricant is known as "rollerine" and is manufactured in eight densities or degrees of hardness to meet the various conditions of service under which "Sells" roller bearings are used. The eight lubricants of different densities are numbered from No. 1 to 8, inclusive. These lubricants have been compounded to give efficient lubrication and to avoid damage to anti-friction bearings caused where lubricants are used which are not perfectly neutral, that is, free from both acid and alkali. A "grease gun" is made for use in "shooting" rollerine through the oil-hole in the bearing box.

Features of Hyatt Roller Bearings

The familiar type of roller bearing made by the Hyatt Roller Bearing Co., Metropolitan Tower, New York City, was originally developed for use on sugar cane crushing mills. The flexible roller was found to stand up without wear under the heavy loads and shocks of this powerful machinery. These bearings are now used in automobile transmissions, wheels, etc.; in farm tractors; and in industrial machinery of all kinds. The Industrial Bearings Division of this company specializes on the application of Hyatt roller bearings to industrial machinery. Extremely satisfactory results have been obtained through the use of this type of bearing in many classes of equipment used in the machine shop. For the benefit of those who are not familiar with features of Hyatt bearings, it may be mentioned that the rollers are made of a piece of steel of spiral form, as shown in Fig. 7, with a space left at the center. These rollers are ground so that the outside surface is a true cylinder. Several benefits are claimed for this form of roller construction, chief of which is the fact that the rollers possess a very slight flexibility which enables them to give sufficiently, under the shock of an unexpected or abnormal condition of loading, to present an enlarged contact area and thus to protect both the rollers and other parts of the bearing from damage. This deflection is less than the thickness of the oil film in a plain bearing. Another advantage claimed for this special form of rollers is that they facilitate the distribution of lubricant over the bearing surfaces and thus increase the efficiency of power transmission. The way in which this result is accomplished is as follows: Alternate rollers are mounted in the bearing with the spiral running in opposite directions; that is to say, the spiral of one roller is right-hand and of the next roller, left-hand, etc. The spiral shaped groove running around any roller in the bearing gathers up a supply of lubricant and as the roller rotates between the outer raceway and shaft, a portion of this lubricant is uniformly distributed.

It will be recalled that the spiral groove in the next roller runs in the opposite direction, so that rotation of this roller results in distributing a supply of lubricant over the outer raceway and shaft in the opposite direction. With alternate rollers distributing lubricant in opposite directions, it will be apparent that the bearing must certainly be thoroughly lubricated at all times, provided a supply of oil is kept in the reservoir in the bearing housing, from which the spiral grooves in the rollers can replenish their supply of lubricant. In Fig. 8 there is shown a special mechanism built by the Hyatt Roller Bearing Co. to demonstrate the way in which lubricant is distributed by the spiral grooves in the rollers. This consists of a standard Hyatt roller bearing with a glass cylinder substituted in place of the usual outer race. When the bearing rotates inside of this glass cylinder, it distributes oil in exactly the same way that the lubricant is distributed over a standard bearing raceway. It will be apparent from this illustration that alternate rollers leave spiral tracks of oil inside the race in the manner which has already been described. In this connection, attention is called to the fact that the dark lines running parallel to the rollers are caused by an accumulation of oil which gathers at each side of the line of contact between the roller and the outer raceway.

The races of Hyatt roller bearings are of two types, namely, the split races, which are suitable for lighter loads and lower speeds, and the solid races, which are used where loads and speeds are higher, or where space available for a bearing is limited. The split outer races are made from a flat piece of cold-rolled steel, rolled into the proper shape. The solid races are made from seamless tubing of alloy steel; carburized, heat-treated, and accurately ground to close limits. The rollers and races of Hyatt roller bearings are so related to each other in degree of hardness that there is no appreciable wear after years of service, and, therefore, it is never necessary to adjust a Hyatt roller bearing.

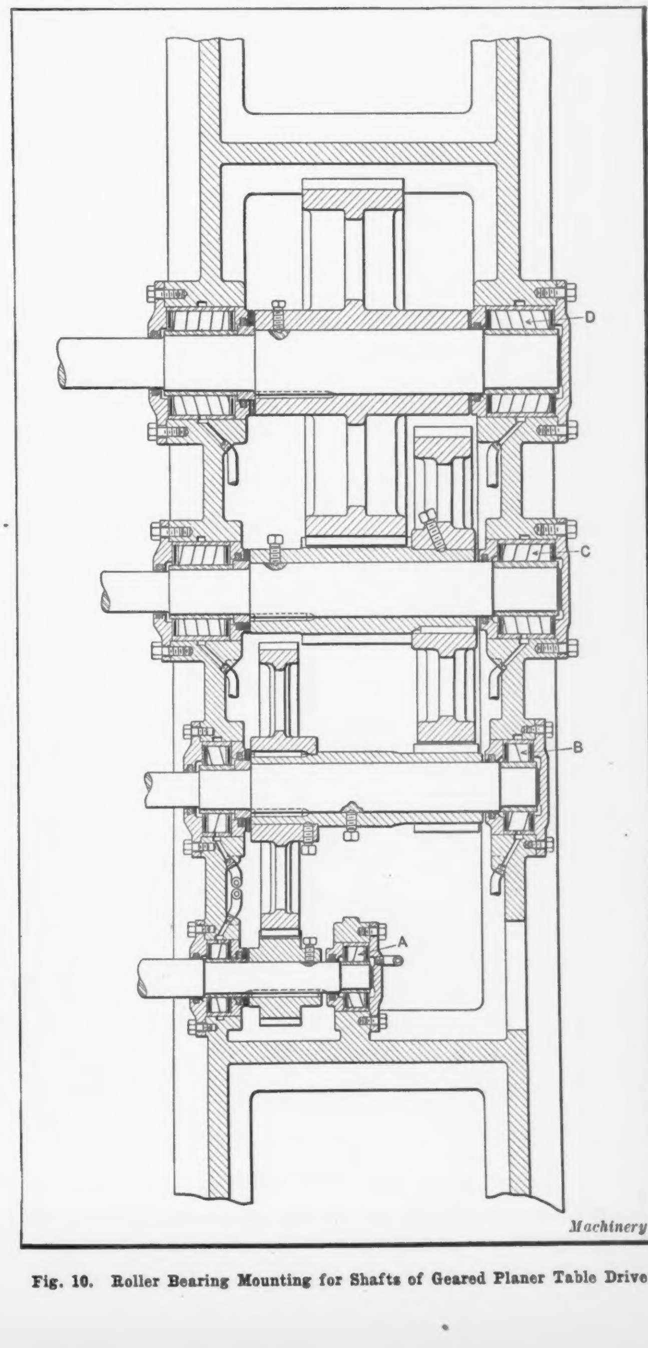


Fig. 10. Roller Bearing Mounting for Shafts of Geared Planer Table Drive

Methods of Mounting Hyatt Roller Bearings

There are various methods of mounting Hyatt roller bearings, the details of which differ according to the particular conditions of service under which the bearings are to operate. Probably the most general method is to have the rollers running directly in contact with the shaft that is carried by the bearings, while outer races are provided inside of the bearing boxes to provide a smooth running track for the rollers. In certain cases, generally when loads are great and space is limited, it will be found necessary to employ inner races between the rollers and the shaft to prevent the rollers from damaging the shaft. The following are typical examples of the application of Hyatt roller bearings in various types of machinery and auxiliary equipment used in the machine shop, and these illustrations show very clearly the different ways in which this type of roller bearing can be mounted to assure obtaining efficient service.

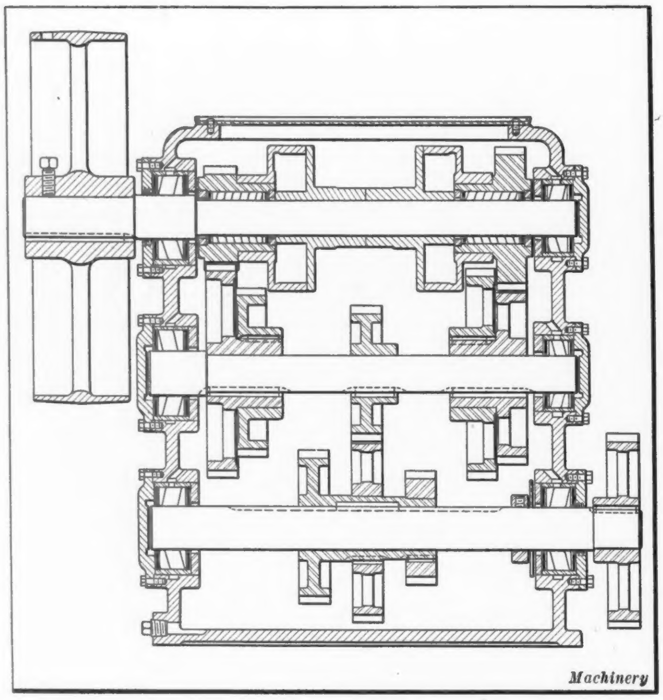


Fig. 11. Application of Roller Bearings for carrying All Shafts in a Machine Tool Gear-box. All Bearings directly on Shafts

Use of Roller Bearings in Engine Lathes

Roller bearings have been tried for supporting the spindles of lathes and other types of machine tools; but in order for a lathe to give satisfactory service, it is necessary to provide bearings for the spindle that can be kept an absolutely tight fit. The existence of even a very slight amount of play causes vibration and chatter, with consequent inaccuracy and a poor finish on the work to be machined. This does not indicate, however, that there is not a field for the application of roller bearings in lathe construction, because such bearings are used with success for carrying those running parts where the existence of a slight amount of lost motion is not detrimental. In Fig. 9 there is shown a typical installation of Hyatt roller bearings in the headstock of an engine lathe. Here it will be seen that the cone pulley is carried by two Hyatt bearings placed one at each end, with the rollers running directly in contact with the lathe spindle, while outer races *A*, which are made of cold-rolled steel, are fitted into spaces bored in the pulley to receive them. It will be apparent from the illustration that a spacing sleeve *B* is placed between the end rings of the retainers on the two pulley bearings, in order to hold these bearings against longitudinal movement toward each other. At the right-hand end, a ring *C* is secured to the hub of the cone pulley by fillister-head screws, in order to prevent the bearings from moving toward the right. Attention is also called to the fact that at each end of the bore in the pulley, there is a grooved ring *D*, which is usually provided with felt packings in the grooves, so that these packings may become saturated with oil and run closely in contact with the shaft, thus preventing grit or other foreign matter from finding its way into the bearings, where it would cause damage.

It will also be seen that the shaft carrying the back-gears is mounted in Hyatt roller bearings, the method of mounting these bearings being essentially the same as that employed in the cone pulley. The rollers run in direct contact with the back-shaft, and the hubs of the back-gears are bored out to receive cold-rolled steel outer races which provide a smooth track for the rollers. It will also be noticed that rings *F*, secured to the outside of the gear hubs by screws, provide for holding the roller bearings against longitudinal movement. As in the case of the cone pulley bearings, provision is made for excluding grit and other foreign matter by means of a grooved ring carrying felt packings, which is placed at the exposed end of each bearing. Attention is called to the fact that the spindle itself is carried in the customary tapered bronze bearings *G*, adjustment of these bearings being accomplished by means of a pair of take-up nuts *H*, which assure freedom from lost motion in the bearings and the production of accurate machine work by the lathe.

Application of Roller Bearings in Planer Drive

On the geared transmission used in a planer bed, profitable use may be made of anti-friction bearings to increase the efficiency of power transmission, insure uninterrupted operation, and facilitate lubrication. In Fig. 10 there is shown a typical example of the installation of Hyatt roller bearings to support

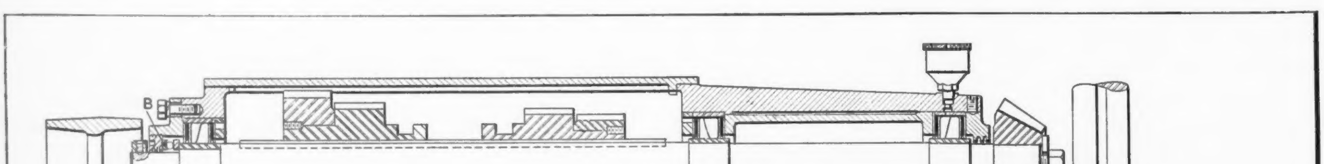


Fig. 12. Application of Roller Bearings for carrying Shafts in Drilling Machine Speed-change Gear-box. Note Application of Ball Thrust Bearings to carry Thrust of Bevel Crown Gears. Gear-box Bearings have Inner Races

all driving shafts in the bed of a machine of this type. It will be apparent from the arrangement of gearing shown in this illustration, that the speed is reduced from shaft to shaft, as a result of which the bearing pressure steadily increases, and so the size of the bearings must increase progressively. That this has actually been done in the present case will be apparent by comparing the sizes of bearings *A*, *B*, *C*, and *D*, from which it will be evident that the projected area of these bearings increases steadily from *A* to *D*, in order to provide for carrying a constantly higher bearing load. The combination of conditions shown in this illustration makes it necessary to carry a fairly high bearing pressure on bearings the size of which is limited by the space that is available. On this account, it was decided to use steel races for the rollers on both the inside and outside, because there would otherwise be danger of the rollers wearing away the shafts, due to the heavy loads on all of these bearings.

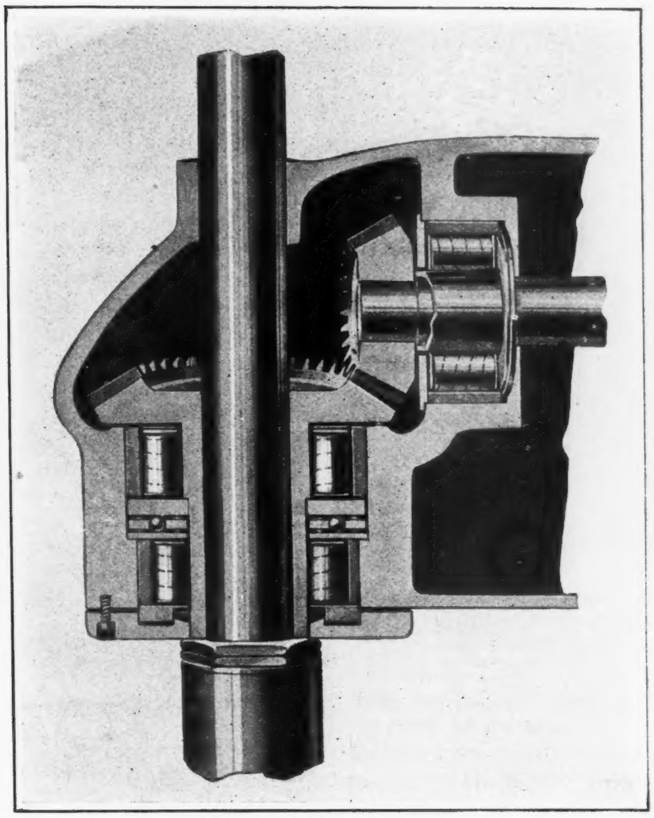


Fig. 13. Another Combination of Roller and Ball Bearings for carrying Combined Radial and Thrust Load

Where this practice of using steel inner races is employed, it may also be desirable to have the design worked out in such a way that the provision of these inner races will not offer any obstruction that prevents the machine from being readily disassembled. This was the case in designing the planer drive shown in Fig. 10, and to provide for this it will be seen that each shaft has been turned down so that the outside diameter of the steel inner races placed on the shaft is not greater than the diameter of the shaft adjacent to the inner races. With such an arrangement, it will be evident that each shaft may be pulled through toward the left, without encountering any obstruction; but if the inner races were secured to the shaft in such a way that they stood above the diameter of the shaft, these races would prevent the shaft from being drawn out when it was desired to disassemble the machine. After reading the description of methods for holding the Hyatt roller bearings in the cone pulley and back-gears of the lathe head shown in Fig. 9, the method of securing the roller bearings in this planer drive will be quite apparent from the illustration. It will be noticed that in both cases, similar methods are employed for excluding dust and other foreign matter from the bearings to avoid danger of scoring the rollers and races, which would decrease their efficiency in the transmission of power.

Roller Bearings in Machine Tool Gear-boxes

In many cases, the designer who contemplates the use of anti-friction bearings of a type where a decision must be made as to whether or not an inner race should be employed between the rollers and the shaft, may either decide to use an inner race of cold-rolled steel or to heat-treat the shaft in order to give it the desired physical properties to resist wear. In the gear-box shown in Fig. 11, which is a typical example of the design used on milling machines, boring mills, etc., the bearing pressure is too high to enable the rollers to be run directly upon soft steel shafts. In this case, the designer decided to heat-treat the shafts to enable them to resist wear. This is often less expensive than to use inner races made of steel. Reference to the illustration will make it apparent that the Hyatt roller bearings used in this gear-box are held in place by means of caps fitting over the holes bored to receive them, and that where a shaft extends through the bearing mounting at both sides, use is made of grooved retaining rings with felt packings, to provide for excluding grit and other foreign matter from the bearings.

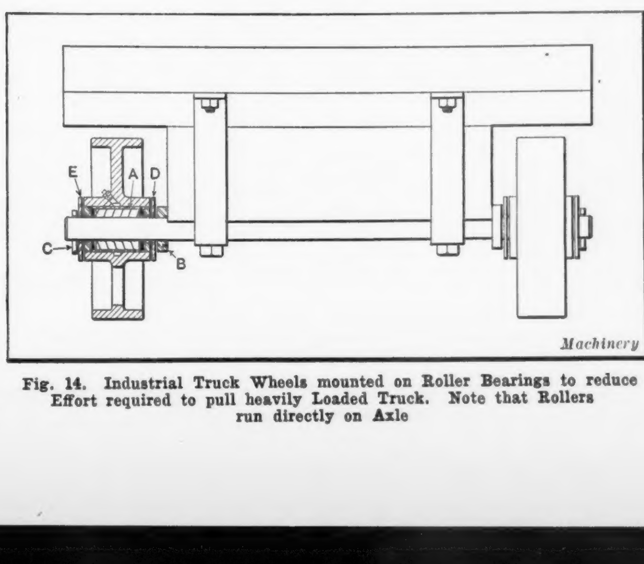


Fig. 14. Industrial Truck Wheels mounted on Roller Bearings to reduce Effort required to pull heavily Loaded Truck. Note that Rollers run directly on Axle

Use of Hyatt Roller Bearings on Drilling Machines

Roller bearings find successful application for carrying gears, pulleys, and driving shafts on drilling machines. Owing to their operation at exceptionally high speed, it may be necessary to furnish Hyatt roller bearings used in this class of service with inner races to avoid wearing the shafts, the practice being the same as that shown in Fig. 10, where inner races were provided on bearings of the planer drive owing to the exceptionally high pressures which existed in these bearings. In Fig. 12 there is shown the upper part of a drilling machine in which it will be seen that the driving shaft, gear-box, and crown gears are furnished with Hyatt roller bearings. In all of these bearings it is necessary to employ inner races because the speeds are sufficiently high to cause danger of wearing the shafts. If the machine tool designer prefers, he may discard the inner race and use heat-treated shafts. In general respects, this installation combines features of the lathe head and planer drive installations, which have already been described, both as regards the method of mounting the bearings and the practice of turning down the shafts so that inner races for the rollers are located on a level with the surface of the shaft to provide for freedom from obstruction in disassembling the machine.

An interesting feature of this installation is the way in which use has been made of a combination of Hyatt roller bearings and ball thrust bearings. It will be apparent that as this is a drilling machine, there will be a thrust load on the spindle in addition to a radial load, thus making it necessary to provide some form of thrust bearing. As Hyatt roller bearings are strictly radial bearings, other means had to be provided for carrying the spindle thrust, and for this purpose use was made of a ball bearing as shown at *A*. Drive from the speed-box to the spindle is through the usual arrangement of bevel crown gears, and with any bevel gear drive there is a certain amount of end thrust imposed upon both shafts. Bearing *A* very easily takes care of this additional thrust load applied on the drilling machine spindle, while the thrust load on the horizontal shaft from the gear-box is carried by a ball thrust bearing *B* mounted at the rear end of this shaft. Another application of a com-

bination of Hyatt roller and ball bearings for carrying the crown gears on a drilling machine is shown in Fig. 13.

Roller Bearings in Wheels of Industrial Trucks

Trucks used for transporting loads of raw material and product around industrial plants are usually made with quite small wheels in order to facilitate the work of lifting heavy loads onto and off the trucks. But these small wheels make it harder to move the loaded truck, and as such trucks are generally pulled by hand, it is desirable to reduce frictional resistance as far as possible in order to reduce to a minimum the amount of work required to pull the truck. Builders of some types of industrial trucks are now using Hyatt roller bearings for this purpose, and Fig. 14 shows a typical example of the way in which a Hyatt roller bearing is mounted in the hub of a truck wheel. Here it will be seen that it is merely necessary to bore out the hub to receive an outer race *A* made from cold-rolled steel, which is of the proper size to receive rollers which run directly in contact with the axle of the truck. It will be apparent that the wheels are held on the axle by means of collars *B* and cotter-pins *C*. Two collars *D* and *E*, which are placed between collar *B* and the wheel at one side and between cotter-pins *C* and the wheel at the other side, fit snugly against the ends of the wheel hub and prevent the roller bearing from working out of place. Only a moderate additional expense is involved in equipping a truck with Hyatt bearings in this way, and the reduction of effort required to pull a loaded truck through the substitution of these anti-friction bearings affords a strong talking point for the salesman.

It has been the aim in writing this discussion of the application of roller bearings in machine shop equipment to explain the latest practice in the use of this type of anti-friction bearings. The second installment of the article, which will appear in the November number of MACHINERY, will continue the explanation of how machine designers are applying roller bearings in machine tools, countershafts, lineshaft hangers, etc. There will also be presented a discussion of the best practice in the lubrication of bearings of this type.

* * *

UNIFORM EXPANSION

BY FRED R. DANIELS

Although the device shown in the accompanying illustration for obtaining a uniform expansion is applied to textile machinery, it involves a mechanical movement which is of general interest. The device is operated by rod *R*, which is composed of five threaded sections. The center rod is threaded on each end and has a bearing in the fixed center support *D*, the effect being equivalent to six sections instead of five. The couplings *C* which join sections *D* are 1½ inch long, and the cast-iron ends of the case *G*, which provide bearings for the ends are 1 inch thick. The intermediate nuts *B* are also 1 inch thick.

As shown in the illustration, the similarly located rod sections on each side of the center have opposite-hand threads and are of single, double, and triple lead, respectively. When the handle on *R* is turned, the nuts *B*, of which there are six, advance toward their respective ends. The travel of the intermediate nuts is limited by the couplings *C*, and that of the end nuts by the confines of the case.

Assume, for example, that the shortest contraction equals 30 inches, then each section, represented by $\frac{x}{6}$, will equal 5 inches. Now when rod *R* is turned a sufficient number of revolutions to have advanced rods *c* and *e* a distance of 1 inch in opposite directions, the two center spaces become 6 inches long. At the same operation, rods *c* and *e* have shortened the two intermediate sections 1 inch, while rods *b* and *f* have lengthened them 2 inches, making a net gain of 1 inch; thus the intermediate spaces also become 6 inches long. Similarly, rods *b* and *f* having advanced toward their respective ends a distance of 2 inches, and rods *a* and *g* having traveled 3 inches, the end sections will also have gained a net distance of 1 inch, and, like the other sections, will be 6 inches in length.

To obtain the desired expansion, it is necessary to calculate the travel of the nuts. From these distances the lengths of the rod sections necessary for obtaining the desired expansion for any given limit may be readily determined by the following formulas:

Let x = minimum contraction over all; then:

$$\frac{x}{6} = \text{length of each section}$$

$$\frac{x}{6} - (1\tfrac{1}{2} + 1) = \frac{x}{6} - 2\tfrac{1}{2} = \frac{x - 15}{6} = \text{allowable travel of intermediate nuts}$$

(The combined length of the coupling and nut = 2½ inches.)

Let y = total travel of end nuts; then:

$$\frac{y}{2} = \text{travel of each nut}$$

$$\frac{y}{2} : \text{travel of intermediate nuts} = 3 : 2, \text{ or}$$

$$\frac{y}{2} : \frac{x - 15}{6} = 3 : 2$$

$$y = \frac{3x - 45}{6} = \frac{x - 15}{2} = \text{total expansion of end nuts}$$

Let z = maximum length; then:

$$z = x + y, \text{ or } z = x + \frac{x - 15}{2} = \frac{3x - 15}{2} = \text{(maximum length)}$$

When the maximum length is known, the shortest contraction may be derived as follows:

Let x = shortest or minimum contraction; then:

$$x = z - y, \text{ or } x = \frac{3x - 15}{2} - y$$

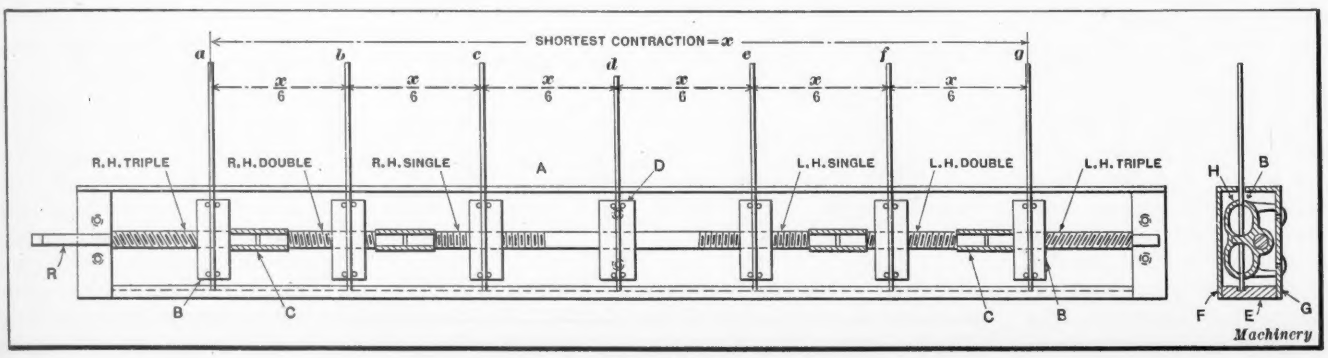
$$2x = 3x - 15 - 2y$$

$$x = 2y + 15$$

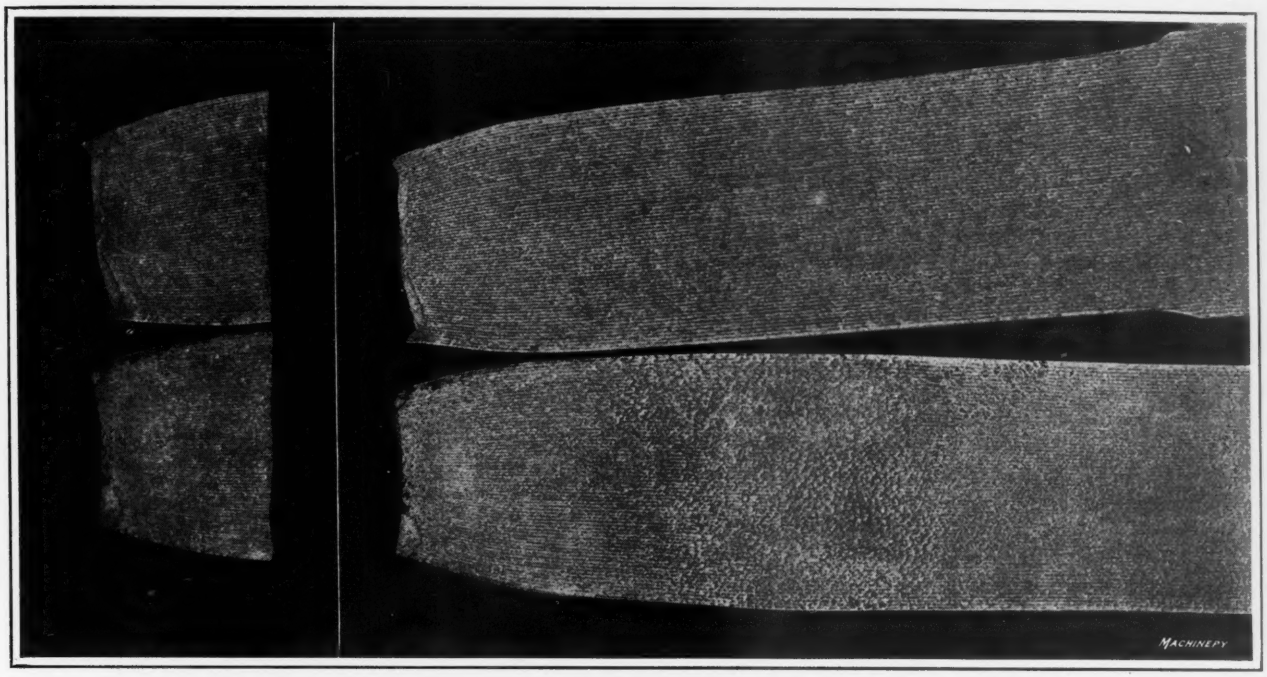
In the illustration, *F* is the cover of the case, *H* the caps of the nuts, and *E* the bottom of the case. The case *G* and the cover are made of sheet metal and the bottom *E* of cast iron.

* * *

It is said that a renowned scientist admitted to a few of his friends that after a lifetime of study he was still unable to understand the electric light. Whereupon his host explained: "It's perfectly simple. You press this button—so, and the lamps light. You press this other button and the lamps are extinguished. That's all there is to it."



Device for obtaining Uniform Expansion



Figs. 22 and 23. Welded and Unwelded Test Pieces, nearly Full Size. Welded Pieces below, Unwelded Pieces above

FUSION WELDING FALLACIES—4

BY S. W. MILLER[1]

IN preceding numbers of MACHINERY some of the common fallacies relating to fusion welding have been dealt with. In the present article one more of the common fallacies will be considered. In this connection it should be thoroughly impressed upon all who use fusion welding that no weld except the best should be considered in any important work, especially where life may be in danger by a failure, and the common opinion that if a tensile test piece breaks outside the weld, the weld is necessarily a good one, should be corrected. At the present time no one knows how dangerous or safe a weld is until it is put into service and tried. The ordinary tests are not sufficient, because they do not take the element of time into consideration. The writer admits freely the difficulty of the problem, but it must be solved and undoubtedly will be. At any rate, it is wrong to take the position that any imperfection in an important weld may be overlooked or considered of little consequence, although such a position has been taken in a number of instances. From the commercial standpoint, also, it is foolish to countenance a defective weld, because the better the weld, the less metal, time, and gas are consumed in its making, and so it is cheaper to make a good weld than a poor one of the same strength.

The late Dr. F. R. Hutton, past president and honorary secretary of the American Society of Mechanical Engineers and vice-president of the American Museum of Safety, said that "an industrial accident—and a boiler rupture or failure is such an accident—is an economic loss and an indefensible blunder from which the community has a right to be defended by ordinance or legislation." While Doctor Hutton was speaking of boilers especially, it will be noticed that he included all industrial accidents, and so the remark applies to welding, which is an industrial process from which industrial accidents may arise through faulty design, construction, or operation, although the last does not usually concern welders.

Weld is not Necessarily Good Because Test Piece Breaks Outside Weld

The writer has called attention before to the fallacy of the statement that if a tensile test piece breaks outside the weld, the weld is necessarily good. Still, recently he heard several representatives of important welding industries speak of tensile strength as if it were the most important requirement in a weld. The tensile strength of a welded piece depends considerably upon the material in which the weld is made, because the carbon content, if large, increases this strength. Most material that is welded contains not over 0.3 per cent carbon, and, therefore, its tensile strength ranges from 45,000 to 65,000 pounds per square inch. The majority of it is not over 58,000 pounds, and not much of it is less than 48,000 pounds, so that under ordinary conditions there is a range of only 10,000 pounds. The tensile strength of a weld made with low-carbon steel wire is about 52,000 pounds to the square inch; therefore, if the original material has a tensile strength less than this, the piece will break outside the weld under test, and if the strength of the piece is higher than 52,000 pounds, the break will be in the weld. It is, therefore, necessary to know the tensile strength of the material welded in order to make a fair comparison. If a tensile strength of 50,000 pounds to the square inch were always secured in a weld, there would be no objection to using welds for many important structures, as far as tensile strength is concerned.

Ductility and Elongation of Welded Parts

Neither is ductility a true measure of the value of a weld, although it is more important than mere tensile strength. Steel containing 0.2 per cent carbon is very ductile, much more so than steel containing 0.4 per cent carbon, and yet is entirely unsuitable for alternating stresses; while the 0.4 per cent steel is used for such work as railroad car axles. The ductility of a soft piece of steel, when tested in a testing machine, is indicated by its great elongation and reduction of area. The most of this elongation and reduction of area takes place during the last 3 or 4 per cent of the load; that is, if the total load is 30,000 pounds, most of the elongation takes place during the last thousand pounds. No material in service is subjected to such conditions, and, therefore, ductility may be over-rated as a quality of a weld.

The elongation of a normal test piece is of value because the material is quite uniform. With an unannealed welded test piece (in which the elongation of the weld is never over 10 per cent) the usual method of measurement of the elongation will give nearly as high a figure as in the unwelded material; that is, provided the test piece is machined and the material has a smaller tensile strength than the weld. This has occurred many times with the writer, and is a splendid method of faking a test. If an unwelded piece having a tensile strength of 48,000 pounds and an elongation of 35 per cent is compared with a welded piece having a tensile strength of 47,000 pounds and an elongation of 30 per cent, it will be found

[1]Address: Rochester Welding Works, Rochester, N. Y.

that the welded piece will show 97 per cent of the original tensile strength and 85 per cent of the elongation, which is a splendid weld, on paper. When the test piece is examined, however, it will be found that the necking down has occurred entirely outside the weld, so that if the broken ends of the welded and unwelded pieces are examined, the rest of the pieces being hidden, the difference between them cannot be told. The only difference between the tests is that one represents the original material, and the other represents the same material subjected to a drawing heat below the Ac_1 critical point. In a 1/2- by 2-inch weld, the Ac_1 point, as shown by the microscope, is about 2 inches from the center of an oxy-acetylene weld, and much less for an electric arc weld. In Figs. 22 and 23 are shown welded and unwelded test pieces, in nearly full size. The welded samples are shown at the bottom, and the unwelded, above. It will be seen that in Fig. 22 the appearance of the fracture is the same for both samples. In Fig. 23, the weld is a couple of inches to the right of the break, where the section is somewhat rough. The tensile strength of the original material was 47,500 pounds per square inch.

The writer knows of but one set of tests in which any specific attention was given to the question of elongation. To compare the elongation of the weld with that of the various parts of the rest of the piece, and with an unwelded test piece, the elongation should be measured in each 1-inch length of the test piece, if the weld is approximately 1 inch long, and in shorter distances if the weld is shorter; the results will vary because of the different heats to which the different lengths have been subjected. The measurements should be made inside the elastic limit with a Berry strain gage or some other accurate instrument. The test piece should contain an odd number of inches, as the weld should be in the center.

Among the important structures to which welding is applied are pressure vessels that are subjected to variations in pressure, which sometimes cause alternating stresses. Many other pieces, such as shafts, are subjected to alternating stresses; therefore, care should be taken to provide a weld that will have satisfactory resistance to such loading. It has been proved that an ordinary unannealed fusion weld made by any process has not a satisfactory resistance to shock and alternating stresses, so that for all important work it will be necessary to pay more attention to these requirements than to either the tensile strength or ductility. As a result, it is very necessary to produce a welding material that when made into a weld will give satisfactory physical qualities; and the writer does not believe that this problem has been solved by any means. The nature of the alternating stress and shock tests will require careful thought. There is much difference of opinion as to how to make these tests; but any method giving comparative results will give much valuable and needed information.

* * *

TABLE FOR FACILITATING APPLICATION OF LEWIS FORMULA

BY JAMES O'HARA[1]

While the Lewis formula readily gives the safe load of a gear when the pitch and diameter are known, it is difficult to find the correct pitch when the diameter and the load at the pitch point are known. As usually written, the Lewis formula is:

$$W = SPby \qquad (1)$$

in which W = safe load, in pounds;
S = allowable stress for material at given velocity;
P = circular pitch of gear;
b = width of face;
y = Lewis factor for circular pitch.

The width of face b can be expressed in some proportion of the circular pitch P, as $b = kP$, in which case k is the ratio of b to P and can be assumed or calculated. Formula (1) may, therefore be written $W = SPkPy$. When the number of teeth N and the diameter d of the gear are known, the circular pitch is easily found from the formula $P = \frac{\pi d}{N}$. By substituting this value for P, the safe load formula becomes $W = \frac{Sk\pi^2 d^2 y}{N^2}$, which may be solved for the value

$$\frac{N^2}{y} = \frac{Sk\pi^2 d^2}{W} \qquad (2)$$

The accompanying table gives the value of $\frac{N^2}{y}$ for all gears with from twelve to one hundred teeth, the value of y having been found from the formula $y = 0.124 - \frac{0.684}{N}$. As all the terms in the member $\frac{Sk\pi^2 d^2}{W}$ are known, the value of $\frac{N^2}{y}$ is easily found. Then the number of teeth in the gear will be

TABLE FOR FACILITATING APPLICATION OF LEWIS FORMULA

Number of Teeth N	$\frac{Sk\pi^2d^2}{W} = \frac{N^2}{y}$	Number of Teeth N	$\frac{Sk\pi^2d^2}{W} = \frac{N^2}{y}$	Number of Teeth N	$\frac{Sk\pi^2d^2}{W} = \frac{N^2}{y}$
12	2150	42	16380	72	45280
13	2370	43	17110	73	46490
14	2610	44	17850	74	47720
15	2870	45	18610	75	48960
16	3150	46	19390	76	50230
17	3450	47	20180	77	51500
18	3770	48	20990	78	52790
19	4100	49	21820	79	54100
20	4450	50	22660	80	55440
21	4820	51	23520	81	56780
22	5210	52	24410	82	58140
23	5610	53	25290	83	59510
24	6030	54	26190	84	60900
25	6470	55	27120	85	62310
26	6920	56	28050	86	63730
27	7390	57	29010	87	65170
28	7870	58	29980	88	66630
29	8380	59	30970	89	68100
30	8890	60	31970	90	69590
31	9430	61	32990	91	71090
32	9980	62	34030	92	72610
33	10550	63	35080	93	74140
34	11130	64	36150	94	75700
35	11730	65	37230	95	77290
36	12340	66	38330	96	78850
37	12980	67	39450	97	80450
38	13620	68	40580	98	82060
39	14290	69	41730	99	83700
40	14970	70	42900	100	85350
41	15660	71	44080	...	.....

Machinery

the number in the adjacent left-hand column that is opposite the value nearest to the value of $\frac{N^2}{y}$ just found. Knowing the diameter and the number of teeth, the circular pitch is found from the formula $P = \frac{\pi d}{N}$.

Example—It is desired to find the circular pitch to use on a set of cast-iron gears, 6 inches and 18 inches in diameter, respectively, which are to transmit 5 horsepower at a velocity of 100 feet per minute at the pitch line. Using the smaller gear, which is the weaker in this case, $W = 5 \times \frac{33{,}000}{100} = 1650$ pounds. For cast iron at 100 feet per minute, $S = 8000$. Assuming that $k = 2.5$ and substituting the values,

$$\frac{Sk\pi^2 d^2}{W} = \frac{8000 \times 2.5 \times \pi^2 \times 6^2}{1650} = 4306$$

The nearest value in the column headed $\frac{Sk\pi^2 d^2}{W} = \frac{N^2}{y}$ is 4450; so the number of teeth in the gear is 20, and the circular pitch is:

$$\frac{\pi d}{N} = \frac{3.1416 \times 6}{20} = 0.94248\text{, or 1 inch, approximately}$$

[1]Address: 13 R St., N.E., Washington, D. C.

Machining and Gaging 9.2-inch High-Explosive Howitzer Shells

Machines and Tools Used, Successive Order of Machining Operations, and Complete Gaging Equipment

BY M. H. POTTER[1]

As contracts have been placed by the War Department for 9.2-inch high-explosive shells, all machining and gaging operations on these shells are described in this article for the benefit of manufacturers who are to produce either this particular shell or other large sizes. The practice to be described has been successfully employed in a Canadian plant which produced a large number of 9.2-inch shells for the British Government. The howitzer shells of the same size for the United States Government will be made in accordance with the drawings and specifications prepared for the British shells. There are twenty-nine separate operations on the shell body and eleven operations on the adapter or base plug. These operations will be referred to in the order in which they are performed.

The general type of machine and tool used in each case is mentioned, and all of the working and inspection gages are illustrated. These gage illustrations include the maximum and minimum dimensions allowed. An inspection of these dimensions and those on the shell drawings will show that rather large tolerances or limits are permitted in many cases, especially when comparison is made with the accuracy required in many other branches of munitions manufacture. It is essential, however, to so machine the shell that it has walls of uniform thickness and is quite close to a given weight. Any decided lack of uniformity in wall thickness would affect the balance of the revolving shell during flight and, consequently, it would be deflected from its natural path. The shells must also be quite uniform in weight, as otherwise the range would be affected.

These shells are not ground or polished on the outside, but have the finish left by the turning tool. The inside is finished with a two-bladed reamer, and this surface must be quite smooth to prevent excessive friction between the interior of the shell and the explosive. A sectional view of the shell with the base plug and driving band in place is shown in Fig. 1, which includes an enlarged detail view of the waved ribs for preventing the driving band from slipping, and a section of the driving band itself. A complete list of all operations on the shell body is given in connection with Fig. 2, which will enable the manufacturer, at a glance, to see the nature of these operations and their successive order. The plant which adopted the following practice had an output of 1000 shells per day of 20 hours.

[1]Address: 1621 Green St., W., Toronto, Ontario, Canada.

First Operation—Drilling, Reaming, and Countersinking Fuse Hole

The first operation is performed on five Colburn drilling machines, the drills being 1 11/16 inch in diameter and having special round shanks to suit quick-change chucks. The drill is followed by a reamer and countersink having a diameter of 1.720 inch and an angle of 18 degrees on the countersinking part. Thick-nosed shells are faced off with a tool which fits into a holder having a No. 6 Morse taper shank which enters the machine spindle. Each drilling machine is equipped with an I-beam traveler, air hoist, and shell sling.

A plug gage *A*, Fig. 3, is used to test the diameter of the drilled hole after the first operation. The rough length of the hole is also tested by gage *B*. These two gages are used both for working and inspection. An over-all length gage *C* is used for making a length mark on the shell. This gage has a center or pilot which fits into the fuse hole, and at the opposite end there is a small center punch. This length mark is 1/8 inch beyond the maximum length of the shell.

Second Operation—Cutting Off Open End

The open end of the shell is cut off on five Williams cutting-off machines. Each machine has two tools located opposite each other. These tools are offset 1/16 inch and work toward the center of the shell. The shop inspector transfers the heat number (forging lot number) from the outside wall of the shell to the base after this operation. The inspection gage *D*, Fig. 3, is used to check the length of the shell.

Third Operation—Rough-turning Body and Profile

This work is done on eight 26-inch Fairbanks lathes and fourteen 27-inch Bridgeford lathes. Each machine has a jib crane bolted to the floor, equipped with a chain block and canvas sling. The shell is held by the rough bore on an expanding mandrel operated by means of a hand wrench. Each Fairbanks lathe is equipped with a cam profiling attachment and one toolpost, and each Bridgeford lathe has a link motion for profiling and is equipped with two toolposts, one tool being used for the straight part of the shell and one for the nose. These tools operate at the same time. The Fairbanks lathes cut toward the tailstock and the Bridgeford lathes toward the headstock. Both solid and expanding plug centers are used in the fuse hole to engage the tailstock center. "Tipit" 1¼- by 1½- by 12-inch welded tools are used for this operation.

The double-diameter snap gage *A*, Fig. 4, is used for testing

the body diameter. Gage *B* is for the nose diameter and gage *C* for the profile. These are inspection and working gages.

Fourth Operation—Rough-boring

Five Root & Van Dervoort special boring machines are used for this operation. An I-beam traveler equipped with a chain block and shell hook is provided with each machine. The shell is held in a pneumatically operated collet chuck. The boring is done by a single-point tool held in a heavy boring-bar. This tool is guided along the profile by a slotted cam at the rear of the lathe bed. A 5/8- by 7/8- by 4½-inch high-speed steel tool is used. The working and shop inspection gages for the rough bore are shown at *A*, Fig. 5.

Fifth Operation—Finish-boring

Twenty Amalgamated and ten Bridgeford boring machines are used, and each machine has a jib crane equipped with a chain block and canvas sling. The shell is held in a clamp "pot chuck" for this operation. A Davis two-blade head is used for roughing the straight part of the shell and a Davis two-blade tool for finishing the straight part and profile.

The working gages for testing the bore diameter are shown at *B*, Fig. 5, the larger gage being 6.50 inches, and the smaller one 6.492 inches. The inspection gages are of the same form, the maximum size being 6.510 inches, and the minimum size 6.490 inches. The inspection and working gage for the length of the fuse hole is illustrated at *C*.

Sixth Operation—Finish-boring and Reaming Fuse Hole

Ten Conradson engine lathes provided with I-beam travelers, chain blocks and canvas slings are used for the sixth operation. The shell is held by the finished inside bore on an expanding mandrel operated by a hand wrench. Each lathe has a six-hole turret toolpost. The first tool used is in the form of a centering piece for truing up the shell. The second tool has a single-point cutter for boring and a single blade for facing the 18-degree seat. The third tool is a single-point boring tool with an adjustable stop for boring the fuse hole proper. The fourth tool is an 18-degree rose reamer for facing the fuse seat. The fifth tool is a double-diameter finishing reamer for finishing the two diameters illustrated by the detail view to the left, Fig. 6.

The working and inspection gages are shown at *A*, *B*, and *C*, Fig. 6. Gage *A* is for the diameter of the bore below the fuse hole, gage *B* for the fuse hole proper, and gage *C* for the total length of the fuse hole.

Seventh Operation—Finish-turning Body and Shell Nose

Sixteen Douglas Connecticut lathes of 26½ inches swing are used, and the shells are handled by I-beam travelers equipped with chain blocks and canvas slings. The shell is held by the finished inside bore on an expanding mandrel operated by a hand wrench. An expanding center is used in the nose to fit the tailstock center. The curvature of the profile is controlled by a cam slot at the rear of the lathe bed which is connected with the tool-slide. A stellite tool, 1 inch square by 4¾ inches long, is used and is held almost vertical in a special tool-holder.

Gage *A*, Fig. 7, is used for testing the profile of the head. The body diameter is tested by limit snap gage *B*. The working gage which is illustrated has a maximum size of 9.160 inches and a minimum size of 9.150 inches. The inspection gage has a maximum size of 9.165 inches and a minimum size of 9.145 inches. The working gage for the diameter of the base is partly shown at *C*. The inspection gage for the base end has a maximum size of 9.065 inches and a minimum size of 9.045 inches. Ring inspection gages *D* and *E* are also used for the diameter of the body and rear end.

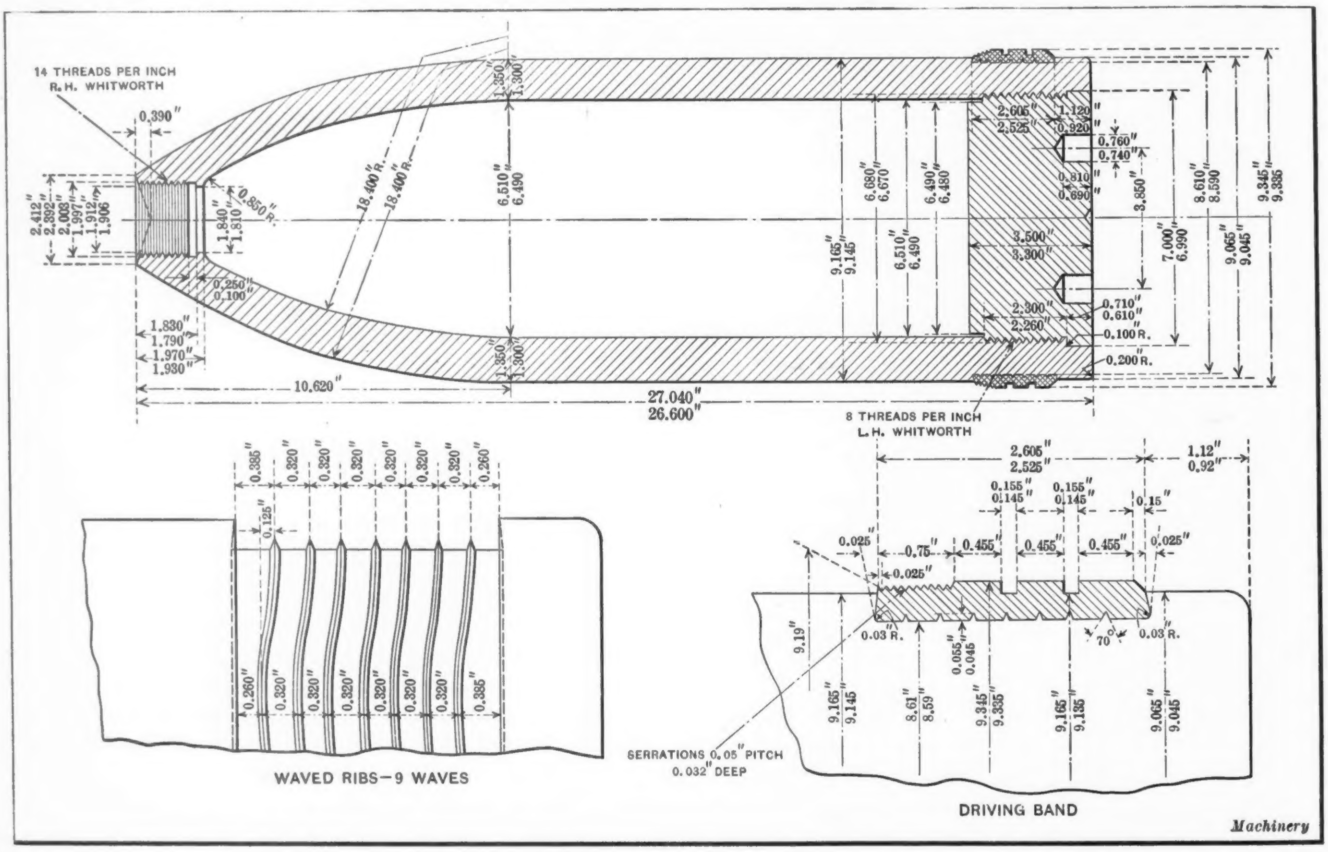


Fig. 1. Sectional View of 9.2-inch High-explosive Howitzer Shell and Enlarged Details of Driving Band Groove and Driving Band

Eighth Operation—Counterboring Base End

Ten Conradson lathes of the projectile type are used. Each machine has an I-beam traveler equipped with chain block and shell hook. The shell is held in a special floating three-jaw chuck at one end. The opposite end is supported and held in alignment by a steadyrest having three solid jaws. The tools are clamped in a four-way turret. One tool is used for rough-counterboring and facing the base and a second tool for finishing the counterbore. These tools are made of one-inch square high-speed steel stock.

The working and inspection gages are shown in Fig. 8. The depth and flatness of the recess in the end of the shell is tested by gage *A* and the over-all length of the shell by gage *B*.

Ninth Operation—Cutting and Waving Driving Band Groove

Eight Root & Van Dervoort special machines are used. The shell is held in a pneumatically operated collet chuck. The

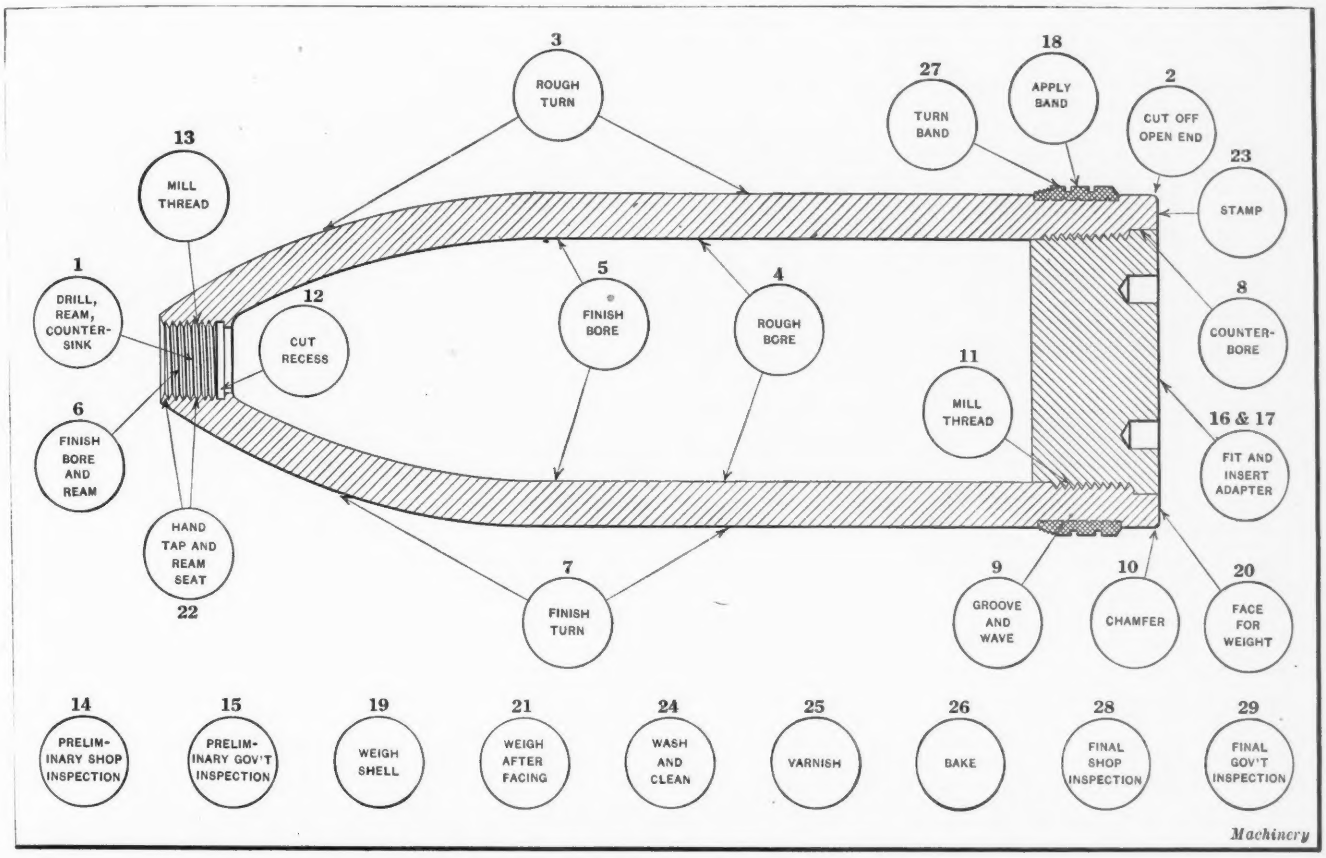


Fig. 2. Nature of Operations on 9.2-inch High-explosive Howitzer Shell and their Successive Order

cross-slide has a block toolpost at the rear and a four-way turret in front. Two parting tools at the rear are used to cut down the sides of the groove and then the tools in the turret are used as follows: First, eight grooves are cut; second, the metal that is left is faced down with a single flat cutter; third, the waves are cut with a flat form cutter, which is given a reciprocating motion for forming the waves by means of a roller in contact with a face cam mounted on the face of the chuck; fourth, the sides of the groove are under-cut by two tools moving in at the proper angle.

The inspection gage for the diameter of the groove is shown at *A*, Fig. 9. The working gage is similar except that the maximum size is 8.605 inches and the minimum size 8.595 inches. The gage *B* is for the width of the groove. One corner of gage *C* is used for testing the distance from the groove to the base. The maximum distance is 1.120 inch and the minimum 0.920 inch. Gage *D* is for testing the shape of the wave or ridge, and gage *E* for the under-cut in the groove. Gages *B*, *C*, *D*, and *E* are both working and inspection gages.

Tenth Operation—Chamfering Base End

A Milwaukee lathe provided with an I-beam traveler, chain block, and canvas sling is used. The shell is held on an expanding mandrel. The corner is chamfered to an angle of 15 degrees to insure the proper centering of the shell in the thread milling machine used for the base end. The working and inspection gages are for testing the form and angle of the chamfer and are not illustrated. The shell end after this operation is shown at *A*, Fig. 10.

Eleventh Operation—Threading Base End

Twelve Holden-Morgan special thread milling machines are used. Each machine has an I-beam traveler equipped with chain block and canvas sling. A multiple milling cutter is used so that the thread (shown at *B*, Fig. 10) is finished in practically one revolution of the shell. This is a left-hand Whitworth thread of 1/8-inch pitch. The working and inspection gage for testing the length of thread is illustrated at *C* in Fig. 10.

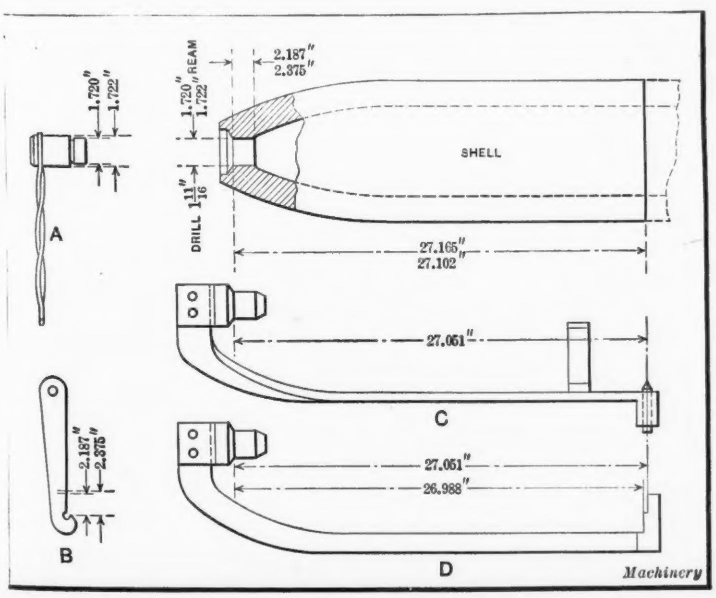


Fig. 3. Shell after First and Second Operations and Gages used

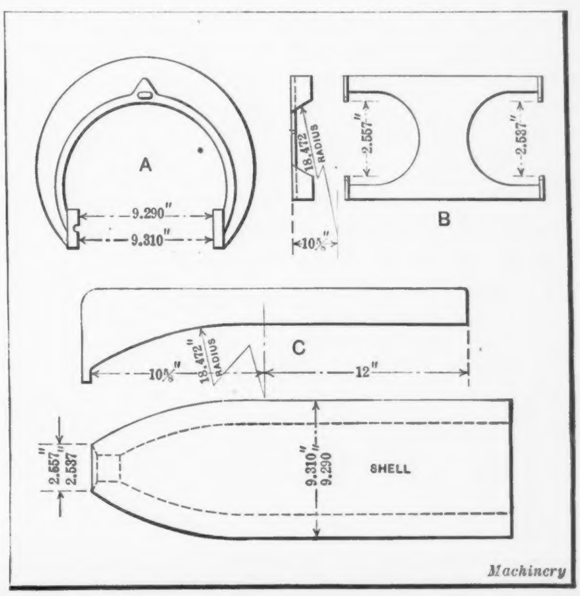


Fig. 4. Gages for Third Operation and Shell

Twelfth Operation—Recessing Fuse Hole

A Holden-Morgan thread milling machine is utilized for this operation. A milling cutter 1 13/16 inch in diameter is used. The distance from the recess to the top of the fuse hole is tested by gage *D*, Fig. 10.

Thirteenth Operation—Threading Shell Nose

Four Holden-Morgan special thread milling machines are used. These are of the multiple-cutter type, which finishes a thread in practically one revolution of the shell. The thread is a right-hand Whitworth standard, and there are fourteen threads per inch.

The working and inspection gages are shown at *E* and *F*, Fig. 10. Gage *F* is for the fuse hole and gage *E* is for testing the thread and angle of the fuse seat. The outside diameter of this gage, 1.999 inch, is 0.002 inch larger than the minimum diameter specified. The minimum and maximum outside and root diameters are indicated on the detail view *G*.

Fourteenth Operation—Preliminary Shop Inspection

After the shells are thoroughly cleaned with gasoline, they are inspected by using the gages shown in Fig. 11. The limit

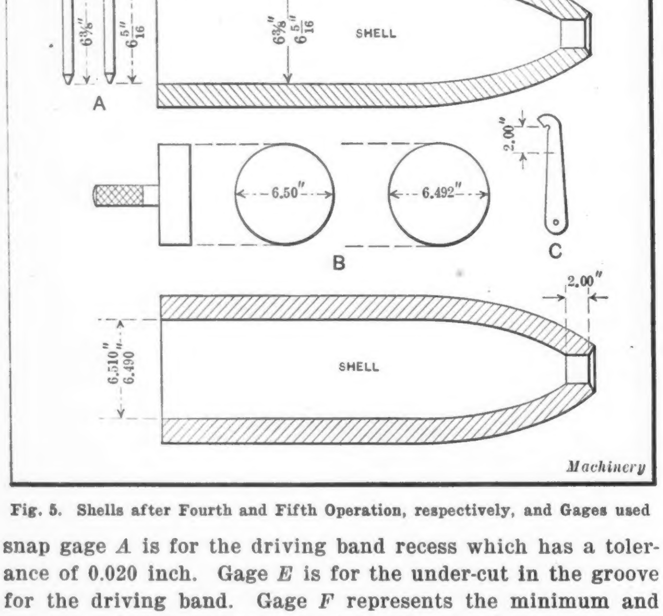


Fig. 5. Shells after Fourth and Fifth Operation, respectively, and Gages used

snap gage *A* is for the driving band recess which has a tolerance of 0.020 inch. Gage *E* is for the under-cut in the groove for the driving band. Gage *F* represents the minimum and maximum lengths of the thread in the shell for the adapter. The plug gages *B* and *C* are for the maximum and minimum diameters of the bore, the tolerance being 0.020 inch. The depth and flatness of the recess for the adapter flange is tested by gage *D*. The maximum and minimum ring gages *H* and *I* are for the shell base or that part of the shell which is back of the driving band. The tolerance in this case is 0.020 inch. The ring gages *J* and *K* are for the shell body, which also has a tolerance of 0.020 inch. The width of the driving band groove and its distance from the base is tested by gage *G*. A tolerance of 0.080 inch is allowed for the band groove width,

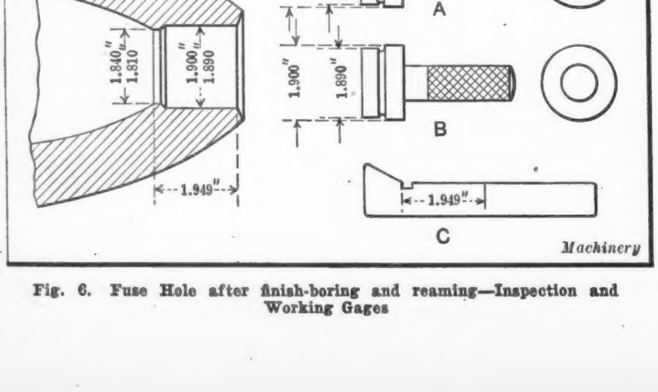


Fig. 6. Fuse Hole after finish-boring and reaming—Inspection and Working Gages

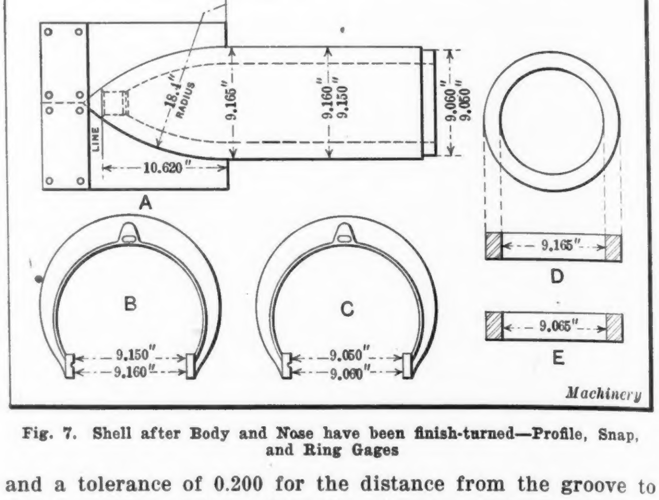


Fig. 7. Shell after Body and Nose have been finish-turned—Profile, Snap, and Ring Gages

and a tolerance of 0.200 for the distance from the groove to the base. Gage *L* is used for the diameter of the bore in the nose below the fuse thread, the tolerance in this case being 0.030 inch.

Fifteenth Operation—Preliminary Government Inspection

Gages similar to those illustrated in Fig. 11 are also used for the preliminary government inspection. In addition, the caliper gage shown in Fig. 12 is employed for measuring the thickness of the shell wall. This gage is of the indicating type, as the illustration shows. A tolerance of 0.050 inch is allowed for the wall thickness.

Sixteenth Operation—Testing Fit of Base Plug

The base plug flange is covered with chalk and the adapter screwed into the shell with a hand wrench in order to test the fit between the flange and shell recess. The nature of the fit is indicated by the bearing marks on the chalked surface when the base plug is removed.

Seventeenth Operation—Inserting Base Plug

Two Root & Van Dervoort belt-driven screwdrivers are used for screwing the base plugs into place and then the plugs are

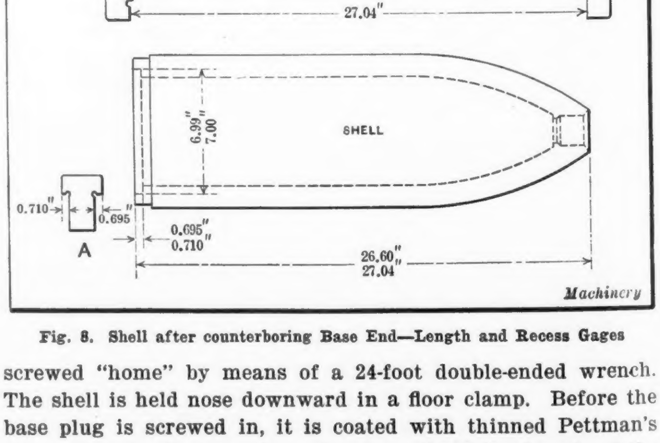


Fig. 8. Shell after counterboring Base End—Length and Recess Gages

screwed "home" by means of a 24-foot double-ended wrench. The shell is held nose downward in a floor clamp. Before the base plug is screwed in, it is coated with thinned Pettman's cement on the flange and on about one-third the length of the screw thread. The remainder of the thread is coated with shellac putty. At *A*, Fig. 13, is shown a sectional view of the base of the shell after the sixteenth and seventeenth operations.

Eighteenth Operation—Applying Band

A West banding press equipped with a pump is used. An I-beam traveler, chain block and shell hook for fitting the inside of the shell nose is employed for handling the shells. Two electric heaters are used, and the band is heated to 1150 degrees F. and is forced on the shell with a pressure of 2400 pounds per square inch. The band is given three "squeezes" and is turned each time in order to seat the ring properly. At *B* is shown the shell end after the eighteenth operation.

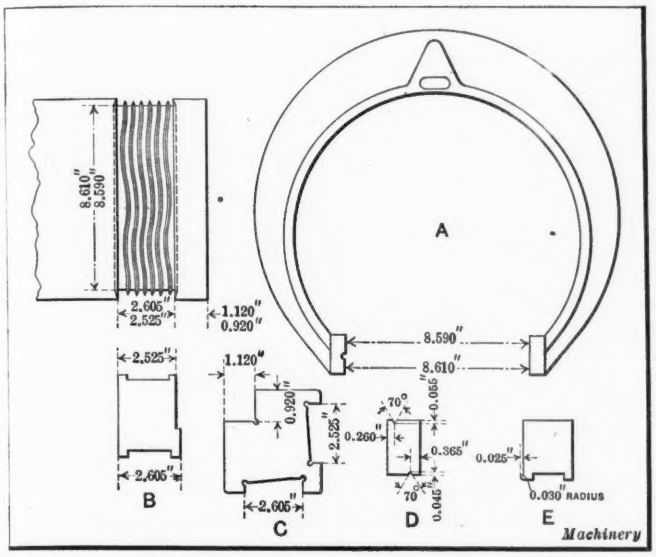


Fig. 9. Driving Band Groove and Gages used

Nineteenth Operation—Weighing Shell

It is now necessary to weigh each shell in order to determine how much metal must be faced off the base end in order to bring the shell within the required limits of weight. The accompanying table, "Approximate Reduction in Weight of 9.2-inch Shell Obtained by Facing Base of Shell," shows, in ounces, how much the weight is reduced for each 1/64 inch faced off, and includes the shell base and plug, the plug only, and the base of the shell without the plug.

The inspection and working gages shown at *C* and *D*, Fig. 13, are used. Gage *C* is for testing the maximum and minimum thickness of the adapter or base plug. One end of this caliper gage extends down through the fuse hole and the adjustable arm on the opposite end is provided with graduation marks to show the maximum and minimum dimensions.

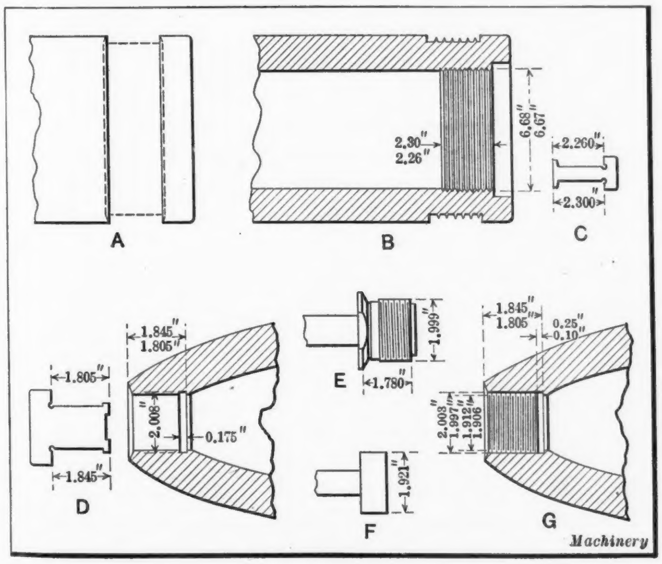


Fig. 10. Chamfering Base End, threading Base, recessing Fuse Hole, and threading Nose

Twentieth Operation—Facing Base to Obtain Correct Weight

Six Milwaukee lathes, each equipped with an I-beam traveler, chain block, and canvas sling, are used. The shell is driven by a center screwed into the fuse hole and a roller steadyrest supports the rear end. A ¾- by 1½-inch high-speed steel tool is used for facing the base and rounding the corner to the correct radius. Gage *A*, Fig. 14, is used for testing the radius, and gage *B*, the distance from the driving band recess or groove to the base.

Twenty-first Operation—Weighing Shell

Each shell is again weighed to make certain that the weight is within the specified limits. The specified weight is 252 pounds 8 ounces, but the shells are allowed to be 1 pound 4 ounces heavier and 2 pounds 8 ounces lighter than the desired weight.

Twenty-second Operation—Hand-tapping Fuse Hole and Finishing Angular Seat

The fuse hole is next hand-tapped with an expanding tap, and the angular seat is hand-reamed to insure a smooth finish. The outside diameter of the tap is 1.999 inch and the tolerance on the fuse hole diameter 0.006 inch. Gages *C* and *D*, Fig. 15, are for testing the maximum and minimum inside or root diameters of the thread in the fuse hole. The tolerance is 0.0145 inch. The distance from the under-cut or recess to the top of the fuse hole is tested by gage *G*. Gage *E* is used for the diameter below the fuse hole thread, and gage *F* for the fuse thread and angle of seat. Gage *H* is for the profile of the head. The nose of the shell after the twenty-second operation is finished is shown by the sectional view Fig. 15.

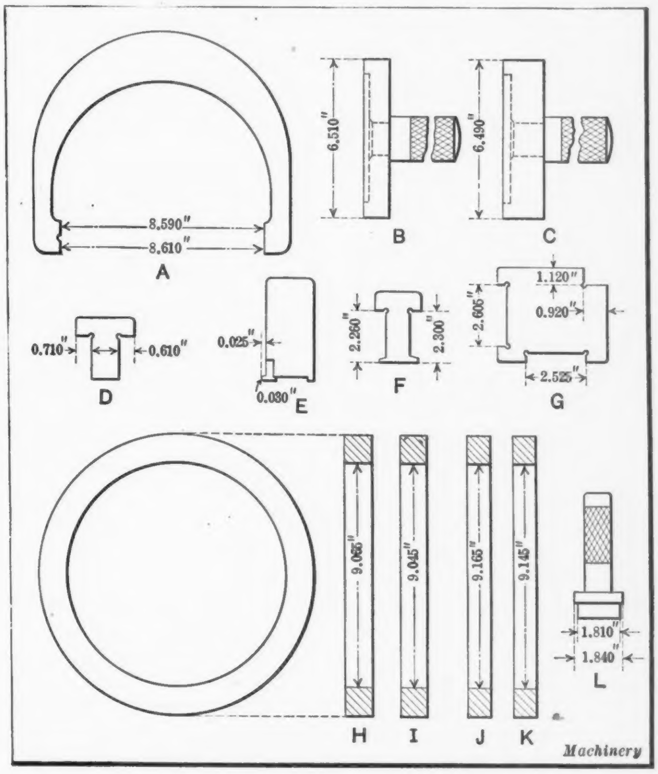


Fig. 11. Gages for Preliminary Shop Inspection

Twenty-third Operation—Stamping Shell Base

The shell is held for stamping in a tilting holder mounted on trunnions. The shell is rolled into the holder, and the fixture which holds the stamps is placed over the base and is held in position by two hand-screws. The shell is then tilted up, and the stamping is transferred to the shell base by means of a sledge hammer. This stamping includes the shell diameter, its mark, the lot number, the manufacturer's initials, and the date of completion.

Twenty-fourth Operation—Washing and Cleaning

Two tanks, 40 inches wide by 96 inches long by 36 inches deep, are used. The shells are handled by I-beam travelers, air hoists and shell hooks to fit the inside of the nose. Shells are lowered into a solution of hot water and "Wyandotte"; they are then removed and allowed to dry.

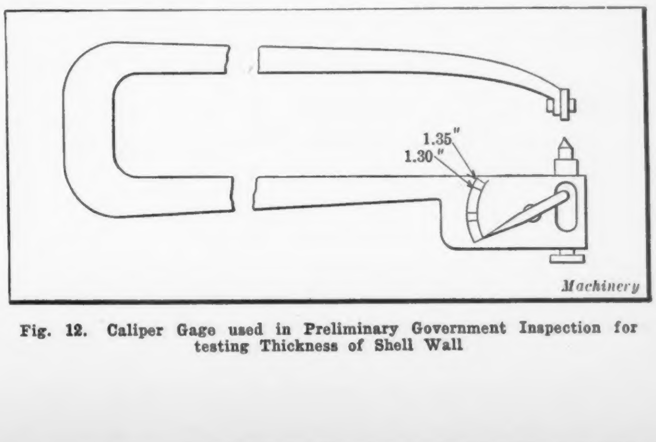


Fig. 12. Caliper Gage used in Preliminary Government Inspection for testing Thickness of Shell Wall

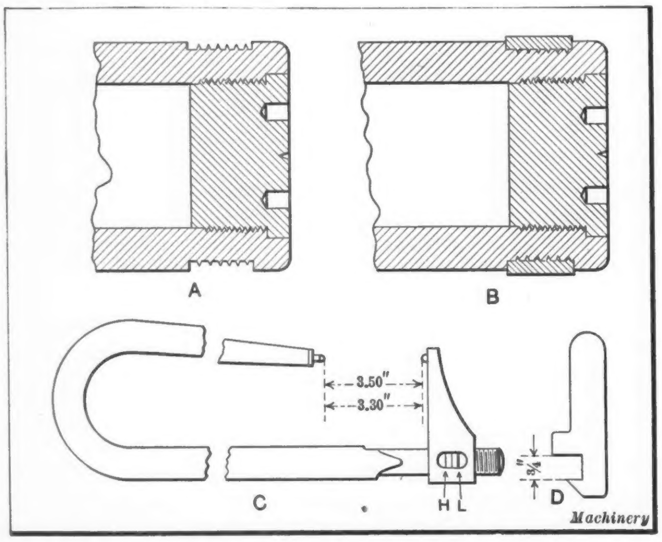


Fig. 13. (A) Base of Shell with Adapter in Place. (B) Adapter and Driving Band in Place. (C) Gage for Thickness of Base. (D) Length Gage for facing Base

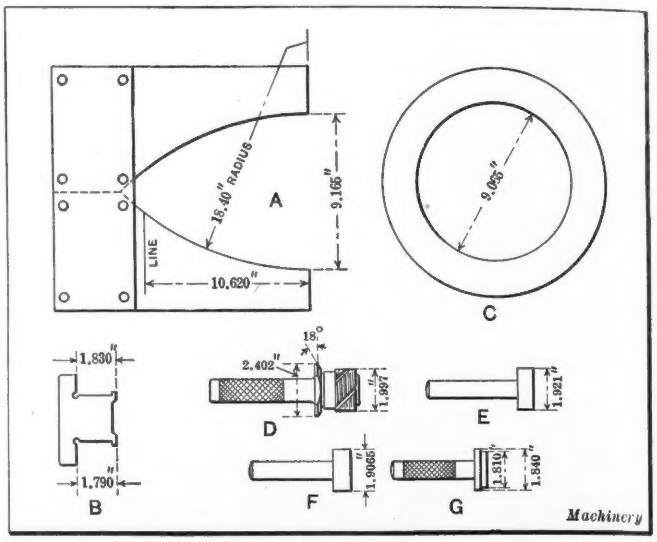


Fig. 14. Gages used for Final Shop Inspection, including Profile Gage A, Recess Gage B, Ring Gage C for Base End, and Gages D to G, inclusive, for Shell Nose

Twenty-fifth Operation—Varnishing

The interior of the shell is varnished by means of a special De Vilbiss varnishing machine. The revolving shell is sprayed with varnish through a nozzle which travels in and out of the shell interior, the varnish being delivered during the return stroke. The shell revolves at about one hundred revolutions per minute.

Twenty-sixth Operation—Baking

Four Brantford gas ovens are used, and each oven is provided with trucks of sufficient size to hold the shells. When the temperature of the oven is 350 degrees F., the trucks holding the shells (which stand on their bases) are rolled in. The temperature of 350 degrees is maintained for two hours, and the shells are then removed and allowed to stand in the open until cool. The shell is now ready for the turning operation on the copper driving band.

APPROXIMATE REDUCTION IN WEIGHT OF 9.2-INCH SHELL OBTAINED BY FACING BASE OF SHELL
Figures in Body of Table Represent Ounces

Amount Faced, Inch	Part of Shell Faced			Amount Faced, Inch	Part of Shell Faced		
	Base and Plug	Plug Only	Base Only		Base and Plug	Plug Only	Base Only
1/64	4.614	2.757	1.857	9/64	41.526	26.814	16.712
1/32	9.228	5.514	3.713	5/32	46.140	27.572	18.568
3/64	13.842	8.271	5.570	11/64	50.754	30.329	20.425
1/16	18.456	11.028	7.427	3/16	55.368	33.086	22.282
5/64	23.070	13.786	9.284	13/64	59.983	35.843	24.139
3/32	27.684	16.543	11.141	7/32	64.597	38.600	25.996
7/64	32.298	19.300	12.998	15/64	69.211	41.358	27.853
1/8	36.912	24.057	14.855	1/4	73.825	44.115	29.710

Machinery

Twenty-seventh Operation—Turning Driving Band

Three Root & Van Dervoort and one Jenckes special band-turning lathes are used. The shell is held in a pneumatically operated collet chuck. On the Root & Van Dervoort machines the cross-slide is equipped with tools that operate in the following order: The band is first trimmed to width by two tools mounted in a block toolpost at the front. A rough-shaving tool at the rear of the cross-slide is next fed across under the shell. The finish-shaving tool, which is mounted directly back of the roughing tool, now feeds across in a similar way. These shaving tools are of the flat formed type. All the tools are operated by the cross-slide handwheel. On the Jenckes machine, the two tools for trimming the band to width are operated by means of a handle which is counterbalanced to move it out of the way when not in use. These tools act on the top of the band. The rough flat forming tool is next

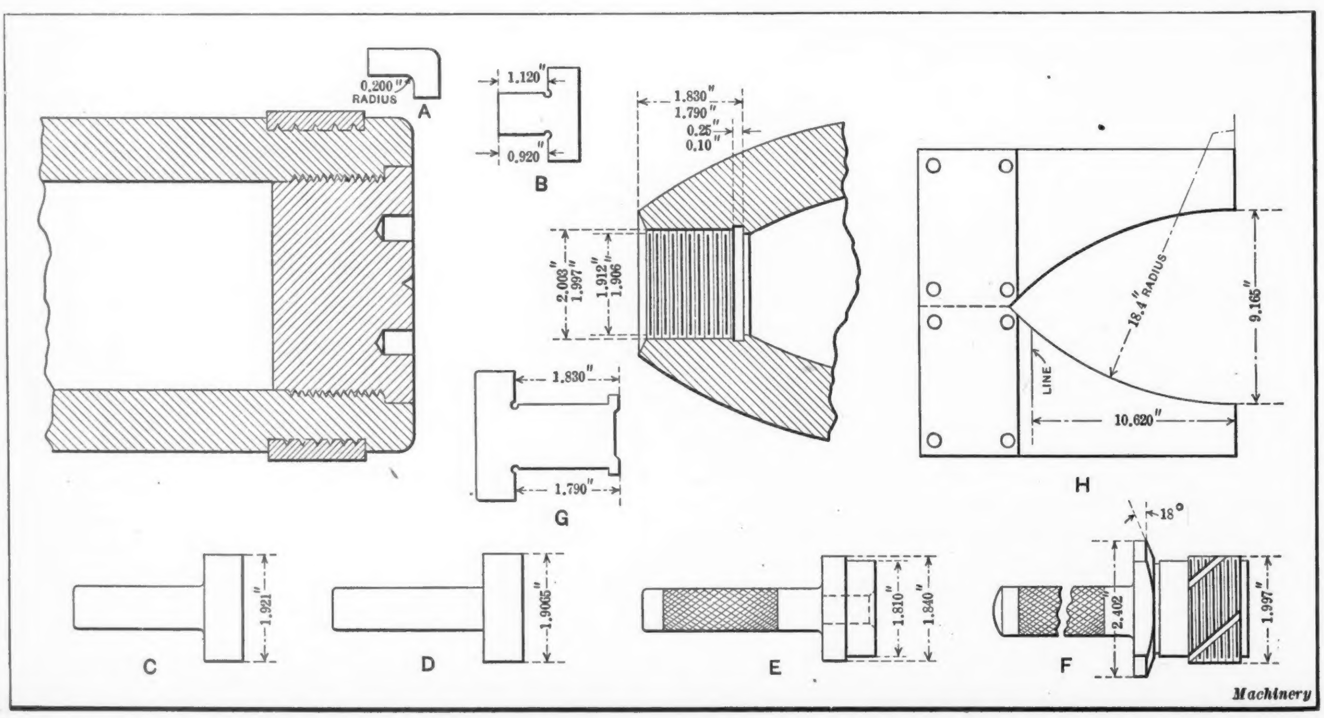


Fig. 15. Base of Shell after End is faced—Nose of Shell after Fuse Hole is finished and Gages used after Twentieth, Twenty-first, and Twenty-second Operations

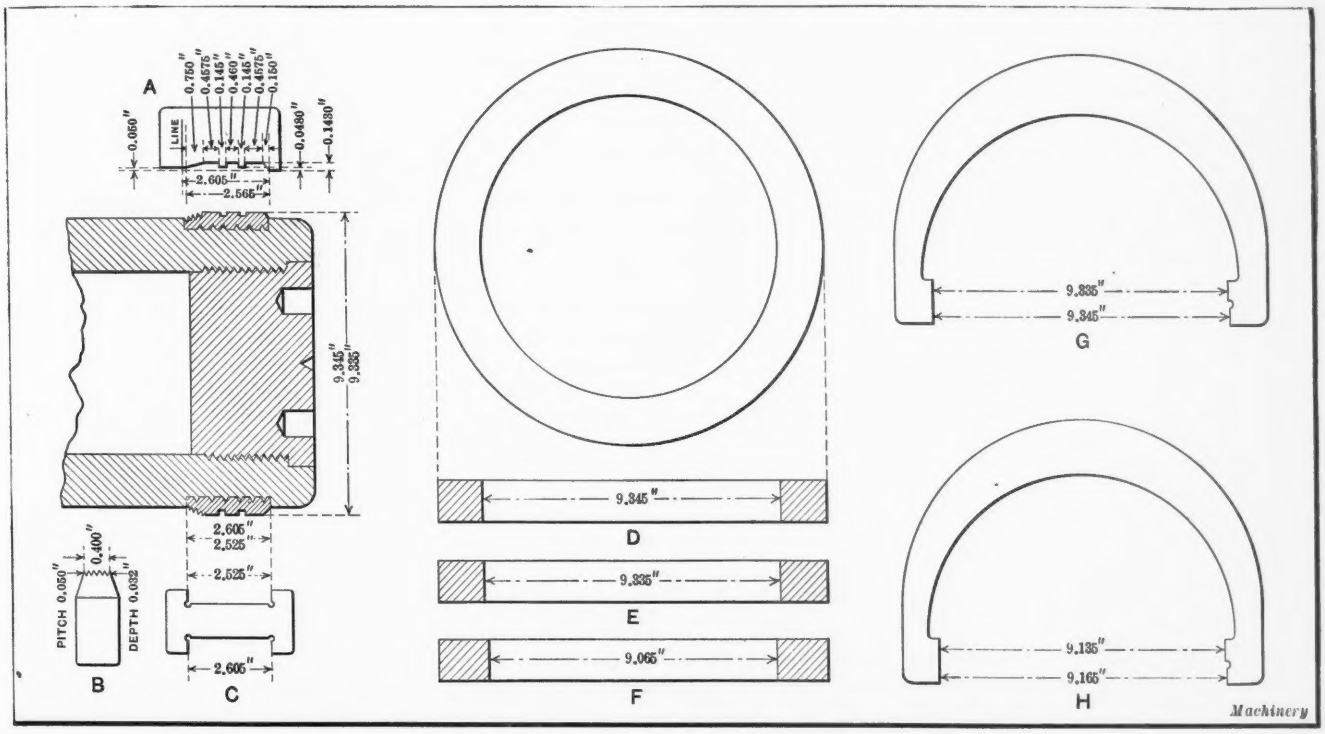


Fig. 16. Driving Band after being turned and Gages for testing Form, Width, and Diameter

fed in at the front by a handwheel. The finish flat-formed shaving tool is then fed across the back of the band.

The inspection and working gages are shown in Fig. 16. The ring gages *D* and *E* are for testing the band diameter, the tolerance being 0.010 inch. Ring gage *F* is for the base diameter. Gage *A* is for the profile of the driving band, and gage *B* for the pitch and form of the serrations in the driving band. The tolerance for the width is 0.080 inch. The limit snap gage *G* is also used for the outside diameter of the driving band, and snap gage *H* is used for the diameter of the gas check or grooves in the driving band. These grooves have a tolerance of 0.030 inch.

Twenty-eighth Operation—Final Shop Inspection

The gages illustrated in Fig. 14 are used for the final shop inspection. Gage *A* is for the profile of the head and gage *B* for the distance from the under-cut or recess in the shell nose to the end or top of the shell. Ring gage *C* is for the diameter of the base, thread gage *D* for the fuse thread and angle of seat, plug gages *E* and *F* for the maximum and minimum inside or root diameters of the thread in the fuse hole, and gage *G* for the diameter of the bore below the fuse hole.

Twenty-ninth Operation—Final Government Inspection

The profile of the head is tested with gage *A*, Fig. 17; the over-all length with gage *B;* the base diameter with ring gage *C;* the thickness of the base with caliper gage *D;* the maximum inside or root diameter of the thread in the fuse hole with gage *E;* the diameter of the bore below the fuse thread with limit gage *F;* the minimum diameter of the thread and angle of seat with gage *G;* the maximum and minimum diameters of the driving band with ring gages *H* and *I;* the maximum and minimum diameters of the driving band with limit snap gage *J;* the width of the driving band

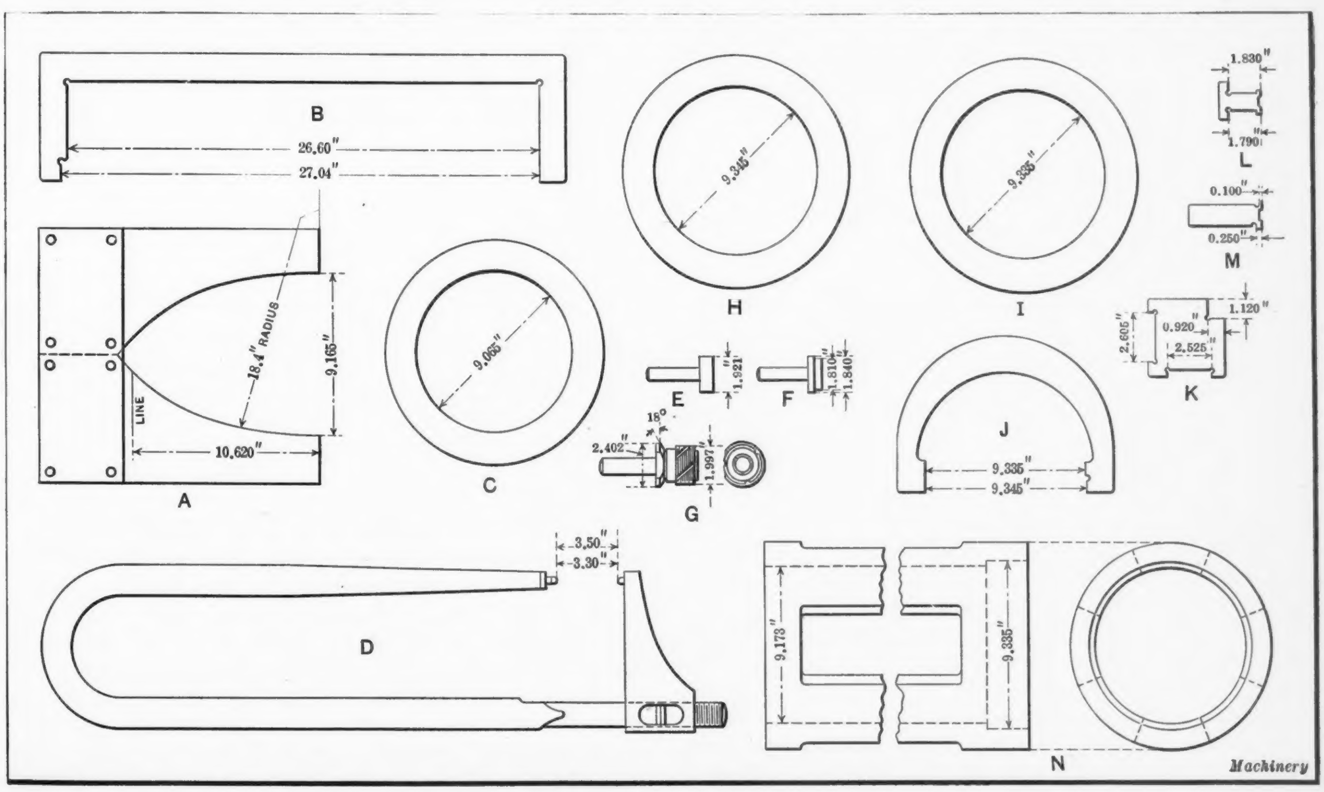


Fig. 17. Gages used for Final Government Inspection

and distance from the base with gage *K;* the profile of the driving band with a gage similar to gage *A*, Fig. 16; the distance from the under-cut or recess in the fuse hole to the top of the hole with gage *L;* the width of the under-cut or recess with gage *M;* and the concentricity of the driving band relative to the shell with gage *N*.

* * *

SCIENTIFIC MANAGEMENT VERSUS ITS PRACTICAL ADAPTATION

BY GEORGE ST. ANDRASSY[1]

True scientific management is practically nothing but discernment of the obvious; horse sense backed by enough education and training to develop ideas into practical results. A reasonably good engineer or accountant is peculiarly fitted by training to succeed in efficiency work, though men of other trades have been very successful in it. The whole theory and profession of scientific management, however, is becoming a subject for jest through the efforts of two types of individuals: The first is the half-trained, self-assertive person who has filled himself with theory but who fails to discern the difference between one business and another and would apply the same methods to all. He lacks the practical experience necessary to instruct others and is fundamentally unfitted for the work and unable to analyze the small details that go to make up any action of life. The second is the person with a scientific mind. He has a thirst for knowledge and is willing to spend two dollars gathering details about how a dollar's worth of profit ought to be made. He gets up tables and files away information about all kinds and conditions of business and operations, but in many cases neither details, tables, nor information have any practical value, and this management expense goes into the overhead.

In the case of one machinery manufacturer, the first act of the efficiency man was to place in the plant one of his best assistants. Then a planning room was built that occupied more space than was required by the entire office force, and the special furniture, racks, boards, and other things installed represented more material and expense than the equipment of the office and drafting-room combined. The factory was thoroughly combed over for the unknown—the *x* factor of the business. In a very short while thirty-two non-producers were connected with this planning room or efficiency branch of the business, increasing the labor cost about eight hundred dollars a week. The cards and forms to be used with the system, just the shop and office stuff that never reached the outside, cost about twenty-five dollars a week; in addition to which there were other expenses. For this money the firm received: A rearrangement of machinery that was better when some products were manufactured, but caused trouble when other products were produced; a more complicated system of giving out tools; a more careful system of storekeeping for raw stock and toolroom supplies; detailed information as regards material, jigs, time, tools, speed of operation, labor, movement of material, packing, and all the small particulars of everything that went through the factory.

Before it was abandoned, this system cost the manufacturer fifty thousand dollars. Yet it was a good system and had worked very profitably in another factory, which made a staple line of products—just the same things day after day in an unending repetition of the same movements; while the factory in which it failed had few staples, and these were large machines that sold in single items and not in dozens. The main business was special machinery, and machines of exactly the same design might not be built again for several years, if at all. The practical mind would have instantly recognized the fact that expensively acquired information that had a doubtful future use was not worth while.

It is a source of satisfaction to know that the best possible way to fashion a piece of steel is to put it on a certain machine, fitted with a particular jig, and using a special tool that takes a cut of a certain depth at a defined speed. Satisfaction, however, does not count for much in the payroll, and if the gathering of this information costs fifty dollars, whereas the saving is figured in cents, the practical mind rather questions the value of such exact information. If it is a matter of duplication, where half a million or more parts exactly alike are to be manufactured, the case is different, for a few cents saved on each will produce a profit. This sense of the obvious is more necessary for the execution or laying out of practical management than all the system, special fixtures or apparatus, tables, forms, etc., that can be crowded into a business.

Scientific management suffers from a severe attack of systemitis and red-tapeitis. The basic facts are good. Pretty nearly any business can be improved by employing a competent man who has nothing else to think or worry about but improvement. A company employing such a man usually expects too much, and, to get the worth of its money, wants to see the outward indications of the changes and improvements looked for. The average business employs people of ordinary intelligence, and practical and profitable change is more a matter of gathering up the loose ends and organizing a system of execution than it is radically changing present methods. If the man called in will stop systematizing and information gathering when he knows he ought to stop, the business will benefit; but if he feels obliged to continue because more is expected of him or because he wants to know—because he is half-inventor and wants to see some way of his supersede some other way—or because he merely desires to pose as the "great I am," then the business will suffer. It is sometimes the quiet, unobtrusive, meek sort of fellows who produce the best results, but it is usually the loud talkers and the installers of much system that get the coin. As coin is what most people are after, there are more of the second class of efficiency men than there are of the first.

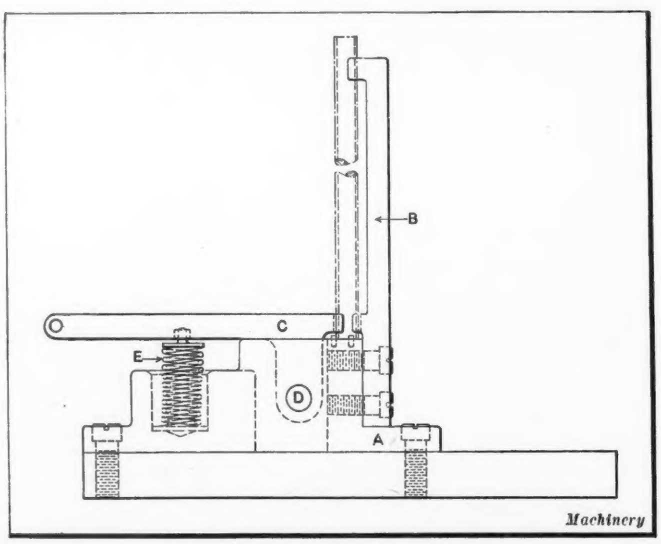
[1]Address: Care of Vulcan Steel Products Co., Inc., 120 Broadway, New York City.

* * *

TUBE RESIZING FIXTURE

The fixture shown in the accompanying illustration was used for holding brass tubes while reducing the diameter of one end for about three-eighths inch of the length with a hollow-mill. As rapid production was desired, it was decided to use a drilling machine instead of a lathe. Then, by holding the hollow-mill in the drill chuck and holding the work in the fixture shown, it was unnecessary to stop the machine while changing work.

The jig consists of a base *A*, a locating and clamping piece *B*, and the clamping jaw *C*, which is hinged on a pin *D* and held in tension by a spring *E*. The jaw *C* is connected through a wire fastened to the outer end, with a foot-treadle, which is depressed while a piece is being placed between the jaw *C* and the locating jaw *B*. When the operator releases the treadle, the piece is held securely by the tension of the spring *E*. As each piece is inserted, the finished piece is pushed out and dropped back of the fixture into a chute, and thence into a box on the floor. This makes the operation very rapid, from five to six thousand pieces being completed per day, depending on the skill of the operator. D. B.



Fixture for reducing Diameter of Brass Tubes

MACHINE TOOL TRADE IN THE SCANDINAVIAN COUNTRIES AFTER THE WAR

BY O. ERICSSON

Manager in the United States, Nielsen & Winther, Ltd., Copenhagen, Denmark

The writer of this article is intimately acquainted with the machine tool trade in the Scandinavian countries, as well as in Russia. For a period of eight years, Mr. Ericsson has been engaged in selling machine tools in Sweden, Norway, Denmark, Finland, and Russia, and previous to that time his engineering activities put him in close contact with both the demands for machine tools and the general conditions in the machine tool trade. His opinions, therefore, will be of interest and value to American machine tool builders.

IN considering the machine tool trade after the war in the Scandinavian countries as it affects American machine tool builders, there are four specific points to be considered: (1) How great will be the demand for machine tools in the Scandinavian countries—Sweden, Norway, and Denmark—after the war? (2) To what extent will the manufacturers of machine tools in these countries be able, themselves, to meet the domestic demand? (3) To what extent will the competition from Germany become a factor? (4) In addition to the machine tool trade for the Scandinavian countries themselves, what other trade is likely to pass over or through these countries? Each of these points will be taken up in detail in the order mentioned.

Demand for Machine Tools After the War

It may be stated without qualifications that the demand for machine tools will be very great after the war, especially in Sweden. The manufacturing industries have developed very rapidly during the war, but have not been able to obtain modern machine tools in large enough quantities to meet the demand. In many instances they are now using old and out-of-date machinery which they will replace with modern tools just as soon as the end of the war will make this possible. There are many activities that have lain almost dormant in the Scandinavian countries during the past two years, at least, due to lack of machinery and other supplies, but plans have been prepared to rush work of this character immediately upon the cessation of hostilities. As the machine tool is the fundamental and basic machine in the production of machinery for all other industries, the demand for machine tools must necessarily be large. Companies are being formed constantly with a view to undertaking the manufacture of different commodities as soon as raw materials are available, all of which indicates a brisk trade in machine tools.

Ability of Scandinavian Machine Tool Builders to Supply Demand

Previous to the war, the machine tool builders in Sweden, Norway, and Denmark were able to supply only a small part of the machine tools required in the large and diversified industries that have been growing up in these countries during recent years. Hence, a very large number of machine tools were imported from America, England, and Germany, the largest proportion of high-class tools coming from America, while Germany supplied a great many machines of what was generally considered secondary quality. As an example, it may be mentioned that one of the largest manufacturing concerns in Sweden—whose products, by the way, are also well known in the United States—would not buy German machine tools, but insisted upon the American product. Hence, the prospect for the American machine tool trade in Sweden was very promising at the beginning of the war, but conditions have changed considerably as the war has progressed, and, as will be outlined in the following, American machine tool builders must take active steps to retain the strong grip that they had on the Scandinavian trade previous to the war.

Denmark was better provided for with regard to the domestic supply of machine tools than Sweden. In the first place, of course, the manufacturing industries of Denmark are not as extensive as those of Sweden and the gross amount of machine tools required is less; and on the other hand, Denmark has the largest machine tool building factory in the Scandinavian countries, able to supply practically the entire Danish demand for machine tools. The manufacturing industries that employ machine tools in Norway are comparatively small, and the Norwegian trade will be of less importance than that of Sweden for many years to come.

As the war proceeded, and it became difficult to obtain from America—as well as from the countries engaged in the war in its early stages—the machine tools required for the Scandinavian trade, a great number of small concerns sprung up in Sweden that began to manufacture machine tools and accessories. There was, for example, only one builder of grinding machines in Sweden previous to the war; now there are several. In one case, for example, a factory that made only twist drill grinders and emery wheels now makes a whole line of grinding machines. Lathe chucks had never before been made in Sweden, but since the war, several manufacturers have gone into this line of business. The same story could be told with regard to other lines of machine tools, but it will be sufficient for the present purpose to mention that there are probably now about a couple of hundred machine tool builders in Sweden, most of these, however, being very small concerns. In Denmark again, the effect has been somewhat different; the large firms that controlled the machine tool business there previous to the war have increased their manufacturing facilities, but comparatively few new builders have engaged in the machine tool business. Furthermore, in all the machine industries, the Danish concerns have specialized more than the Swedish, and are, therefore, in a better position to compete on an economic basis.

When the war is over it is not likely that the small concerns that have sprung up during the war will be able to compete with either the American or the German machine tool trade that will again begin to flow in a steady stream to the Scandinavian countries. It is most likely that the domestic competition, which the American machine tool builder will have to meet, will consist of that from a few comparatively large firms, while the smaller concerns will either go out of business, or turn to other fields of manufacture. The question as to Scandinavian competition with American machine tools may therefore be answered in this way: The domestic competition will not be much keener than it was previous to the war, and in view of the increased demand for machine tools, American machine tool dealers will have a large trade, if there is no other serious competition from abroad.

Effect of German Competition

In the preceding paragraphs, only the Scandinavian machine tool builders have been considered. We now come to the most important question to be discussed in connection with the future of the machine tool trade in the Scandinavian countries, and that is the effect of German competition. This is something that American machine tool builders would do well to consider very carefully. While Germany will be defeated on the battlefield, and must come to such terms as the Allies will demand, Germany will soon recover commercially, and will exert itself to the utmost not only to hold, but to increase, its trade in the neutral countries. The German activity in anticipation of the after-war trade, is already very great, especially in Sweden.

Agencies have been established in great numbers in Stockholm and Malmö, and a number of German firms have also built machine shops in Sweden in which they manufacture machinery which after the war will pass as Swedish products. Of course, the machines that are built in Sweden from Swedish

materials, even though employing German capital, are, strictly speaking, Swedish products, and there is no great harm done in this respect; but the danger is that these factories will merely be trading posts for the great German industries. While they will manufacture a small line of machines, it is probable that the object will be to import a much greater amount to Sweden, either in the form of parts or completed machines, and then to pass these machines out from the Swedish factories as having been manufactured in Sweden.

There is no question that the Germans are working overtime to establish as complete commercial domination over the neutral countries as possible. They realize that they will be cut off elsewhere, and for the first few years the trade that they will be able to maintain through the neutral countries will be of the greatest importance to them. American manufacturers must, therefore, count with the neutrals in laying their plans for after-the-war foreign trade, and must especially consider the geographical position of Sweden and Denmark, which countries no doubt will act as intermediaries in the trade with Russia. The German competition is likely to be the most serious that American machine tool builders will have to face in the Scandinavian countries, and American manufacturers should thoroughly familiarize themselves with this idea.

Future Trade with Russia through Sweden and Denmark

It is very difficult to say anything definitely about Russia at the present time, as we know little or nothing about what is actually going to happen in that vast territory. All that we can say is that Russia will settle down again in one way or another, and at that time will provide an enormous market for machine tools. It is impossible to believe that after the war Russia will be under German political control, but it is quite possible that the German commercial interests will intrench themselves so firmly in Russia that they will largely dominate the trade. Recent indications, however, are to the effect that the pendulum is swinging back and that Russia may come more directly under the commercial influences of the Allies than under the Germans.

In either case, however, a great deal of the machine tool trade between the United States and Russia will no doubt be handled from Sweden and Denmark, and, in that case, the trade to these Scandinavian countries will be of the greatest importance, because Russia will ultimately be able to use greater quantities of machine tools than the Scandinavian countries themselves would buy. If the German interests get a firm foot-hold in Russia, it will become almost imperative that the American trade in machine tools passes over Stockholm, or Copenhagen, as trade with Russia from Sweden and Denmark will be much easier than it would be directly from the United States. In the early part of the war Sweden and Denmark handled a great deal of the trade between the United States and Russia, and it is very likely that this condition will be even more pronounced after the war.

What Should American Machine Tool Builders do to Retain their Grip on Scandinavian Trade?

In view of what has been said, it is evident that neglect of the Scandinavian trade on the part of American machine tool builders is very serious. The Germans are getting a firm grip on the trade, while American builders take no steps to retain the advantage they had previous to the war. The German interests are not selling machine tools in Sweden at the present time to any appreciable extent, but they are establishing themselves in a manner that indicates their ability to look ahead into the future. American manufacturers should do the same. They should realize the importance of the geographical location of the Scandinavian countries with regard to the Russian trade, and should establish responsible native agencies in Sweden or Denmark at the present time so as to be ready to handle the trade without the slightest loss of time when the war is over.

Such agencies could also be more or less directly under the control of the machine tool builders themselves. The Russian trade could also be well handled from such offices in Stockholm or Copenhagen, or at least the headquarters of the Northern European trade could well be located there.

American manufacturers must take steps to counteract the active German influences in the Scandinavian countries. Of course, there would be only small profits from the establishment of these agencies until after the war, but unless something is done *right now*, American machine tool builders will find themselves pretty well cut off from their trade, and it will take them years to build up again the connections which they had previous to the war.

* * *

FACTORY ACCIDENTS

An investigation of the factors causing industrial accidents in England has recently been conducted by Dr. H. M. Vernon on behalf of the Health of Munition Workers Committee, and the results are now available. Data relating to upward of 50,000 accidents were collected during periods ranging from nine months to over two years. Some interesting conclusions are drawn from these data, and various suggestions are made for lessening the risks to which factory workers are exposed. While speed of production is an extremely large factor, Dr. Vernon states that accidents are largely due to carelessness and inattention, and could be diminished by preventing the workers from talking to one another. At all the factories the night shift workers suffered fewer accidents than those on the day shift. This is believed to be due to the calmer mental state of the night workers. These workers have nothing immediate to look forward to but an unexhilerating breakfast and rest. Such a mental state is impossible of achievement by the day workers, but something in the way of mental calm and equilibrium can be attained by stopping all conversation except that relating to the work in hand.

Further, the careless state of mind resulting from intemperance is the cause of many accidents. There can be no doubt that the use of alcohol by the workman reduces the quality and quantity of his work, and also increases the likelihood of accidents occurring. Dr. Vernon suggests that further restrictions be made in regard to the sale of intoxicating liquors.

It is pointed out that excessive fatigue, with its accompanying increase of accidents, can be almost entirely avoided by choosing suitable hours of labor. It can also be combated by the introduction of seats for the workers, so that they can rest occasionally when they are not actually working. Also, the most suitable seats possible for sedentary workers should be provided. The influence of fatigue on accidents among women was strikingly shown at a fuse factory, when the operatives were working a twelve-hour day, or seventy-two hours a week. The accidents among women workers were two and one-half times more numerous than in the subsequent ten-hour period, but the number of accidents among men workers showed no difference. Also, the women were treated for faintness nine times more frequently than the men, whereas, in the subsequent ten-hour day period they were treated for faintness only three times more frequently. Even moderately defective lighting produced a considerable increase of eye accidents. Such accidents were 7 to 27 per cent more numerous in the night shifts, and the excess was most marked in the factory having the least efficient lighting system. The use of goggles is suggested as a preventive measure for these accidents.

Temperature is another important factor. It was found that accidents increased rapidly at the higher temperatures inside the factory, and accidents outside the buildings increased considerably as the weather grew colder. Dr. Vernon suggests that thermometers should be installed in the factories, and that the heating apparatus should be on the floor or a few inches above it, so as to warm the feet.

It was found that the women suffered twice as frequently as the men from sprains, and were especially liable to wrist sprains at the fuse factory, as they had not sufficient strength to push home the levers of the lathes. The women at the shell factories suffered nearly four times more burns than the men, chiefly from hot metal turnings. The sprains could be reduced by alterations in the design of the machinery, and the burns by protecting the hands. M. E.

ALUMINUM BRONZE AS AN ENGINEERING MATERIAL

DIFFICULTIES IN CASTING—USE AND CHARACTERISTICS—COMPOSITION—HIGH-TENSILE ALUMINUM BRONZES

BY CHARLES VICKERS[1]

A REVIVAL of the art of casting aluminum bronze has been witnessed in the past three or four years, and as a consequence this alloy which for many years has been non-existent as far as brass foundry operations are concerned, is once more being specified for important engineering work, and much interest has been aroused in regard to its possibilities as a material of construction for sections of the wonderful new machines of the gasoline age. Aluminum bronze is being applied in many diversified ways, in the construction of shipping of all kinds, on railroads, motor trucks, automobiles, tractors, and airplanes, as well as for many other and more ordinary purposes; with the result that every engineer or brass founder in the country is more or less interested in either the physical properties or the casting peculiarities of this alloy.

Early Difficulties Encountered in Casting Aluminum Bronze

Aluminum bronze is not a new alloy; it has been known ever since aluminum has been known, although for many years the high cost of this metal made its alloys with copper impossible as a commercial proposition. When aluminum became cheaper, however, the casting of the bronze was taken up with enthusiasm, and if it had been as easy to handle in the foundry as alloys of copper and tin, there is little doubt but that aluminum bronzes would have become the most important non-ferrous alloys in service. Unfortunately, however, casting difficulties were encountered that soon discouraged the majority of founders and left the alloy in the hands of a few who struggled along with it for a number of years with varying success, until the discovery of the more easily cast alloy known as manganese bronze relegated aluminum bronze to temporary discard.

Some practical suggestions in regard to the casting of aluminum bronze were embodied in a paper read before the American Society of Mechanical Engineers by the late Thomas D. West as far back as November, 1886. Mr. West compared the foundry difficulties incident to casting aluminum bronze to those encountered in the casting of steel. The two metals are similar in behavior when solidifying in molds, as they are both fragile at the moment of solidification, making the castings liable to rupture when the mold opposes contraction, and they both shrink excessively and require large amounts of excess metal in the form of risers and feeders to make good the cavities that form as the result of the diminution of volume that results when the liquid changes to the solid state.

Mr. West gave some excellent advice as to the best way to proceed to get good castings of aluminum bronze, emphasizing the necessity of making the molds and cores so they would part with their strength and solidity after the metal had run into place and while it was congealing. This is partly accomplished by incorporating organic matter with the sand, which being destroyed by the heat allows the walls of the mold to crumble and not oppose the contraction of the fragile metal. In addition to methods of guarding against rupture of the castings, it is necessary to provide large risers and feeders to insure solidity.

Use of Manganese in Aluminum Bronze

Other early workers with aluminum bronze were Dr. John A. Jeancore of Newport, Ky., who was awarded a patent on the application of manganese in aluminum bronze, and the Cowles Bros. of Lockport, N. Y., and Erwin S. Sperry of Bridgeport, Conn. Dr. Jeancore advocated the use of manganese chloride as a flux in melting aluminum bronze, and held to the opinion this was the only chemical possessing value in this connection. Mr. Sperry does not appear to have used anything other than charcoal in making this bronze.

A few foundries have continued to make aluminum bronze castings ever since the metal became a commercial proposition, because it was found the best alloy for certain machine parts. Thus the Niles Tool Works, Hamilton, Ohio, have always used this alloy for certain castings, notably gears weighing from 200 to 350 pounds each. Their veteran brass foundryman, George Ling, employed the Jeancore process, particulars of which were furnished him by Dr. Jeancore himself. This process, as before stated, consisted in using manganese chloride as a flux; the proportion being from one to two per cent.

Difficulty in Obtaining Perfect Aluminum-bronze Castings

The unpopularity of aluminum bronze in the foundry is due to the difficulties of obtaining a reasonable percentage of perfect castings and of preventing the alloy from becoming mixed with the other foundry alloys in which aluminum is harmful. The first difficulty is not as great as it once was, due to the fact that the foundryman is becoming educated to the peculiarities of alloys containing aluminum. He has acquired experience from handling manganese bronze, and this helps him when making aluminum bronze, because the casting difficulties encountered with the two alloys, while differing in degree, are of a similar nature. The experience with manganese bronze has taught that the slipshod methods that formerly prevailed in brass foundries must be abandoned in the case of the modern alloys. The foundryman's favorite alloy is a copper-tin alloy, or a red brass or composition consisting of copper, zinc, tin, and lead, because these alloys are very easy to cast, in that they do not "shrink" or run drossy apparently, and in consequence there is little difficulty in making such castings. Yellow brass, on the other hand, has never been much of a favorite; as a matter of fact, many brass foundries do not handle this alloy at all if they can help it. This is because of the difficulty of casting it, owing to the smoke and fuss it makes when going into the molds and the likelihood of producing dirty castings if the metal is not poured into the molds in the proper manner and at the correct temperature. These difficulties have been overcome by foundries who specialize on yellow brass, and are thought nothing of; a little study and attention to details is all that is required to cast any alloy successfully in the foundry. Manganese bronze was a more difficult alloy for the brass founder than any he had encountered, but by this time these difficulties have been largely surmounted, and the experience and knowledge thus accumulated is now available and can be applied to the still more difficult alloy, aluminum bronze.

Preventing Aluminum Bronze from Becoming Mixed with Other Alloys in the Foundry

The first objection to aluminum bronze—the difficulty of making the castings—therefore, may be said to be disappearing due to a better understanding of the principles that govern the successful production of castings of copper alloys containing aluminum. The second objection, however, remains, and in the case of aluminum bronze is more serious than in the case of manganese bronze, owing to the fact that it is more difficult to detect spillings of aluminum bronze than of manganese bronze, as the latter metal surface oxidizes to a yellow color, and can be quite easily picked out of the red brass skimmings with which it may have been mixed. Then again, a small admixture of manganese bronze can be carried by composition, without the aluminum showing on the surface of the castings, and if the aluminum fails to show it need cause no anxiety, because it has oxidized and vanished, and may even have done some good by eliminating oxides from the alloy. Aluminum bronze adds such a comparatively large percentage of aluminum to scrap metals that it is very potent in causing trouble from this source. Aluminum, however, is easily oxidized at the temperature of molten brass, and little difficulty ought to be experienced in getting a flux that will remove the aluminum when its presence is undesirable in a pot of molten brass or bronze.

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The use of special casting floors for aluminum bronze will largely eliminate difficulties caused by this alloy becoming mixed with the metals that are harmed by aluminum. This has been practiced in the case of manganese bronze with good results. In the cleaning department, also, a large percentage of the chips can be segregated by the exercise of a little care. Of course, the grindings will be mixed with aluminum bronze, but if these are mixed with copper oxide and a little soda ash and are smelted, the resulting metal will be free from aluminum. There is no question but that certain alloys of aluminum copper and iron have come to stay, as their physical properties are such that they cannot now be dispensed with just because they may be a little difficult to cast and may cause annoyance in the foundry. Somebody will make them and reap monetary reward in the near future, therefore, the enterprising foundryman will begin to familiarize himself with the peculiarities of this alloy, as they affect him, and will not wait until he has a chance to bid on some large contract, but is fearful whether he can make good, and so holds off until someone else gets it.

Characteristics of Aluminum Bronze

Aluminum bronze is a good die-casting material, as it possesses the fluidity necessary for completely filling the dies, is malleable at a red heat, does not blow excessively in contact with steel surfaces, and does not surface oxidize and scale when removed from the molds hot. It has two serious drawbacks: it runs drossy and shrinks excessively. To overcome the drossing tendency, it is necessary to introduce the metal into the mold by what is often a roundabout way, in order for it to enter quietly, and this makes it difficult to run some castings successfully in metal molds in spite of its fluidity, as the molds abstract the heat rapidly from the molten metal. Its great shrinkage makes it difficult to turn out die-castings without internal shrinkage cavities, if they are somewhat massive in form. The best way to accomplish this is to use risers of some heat-conserving material, to make it possible for the casting to solidify before the riser which is to feed it. Some diemakers attain this end by water-cooling those parts of the mold adjacent to sections of the casting that should congeal quickly, and sometimes air-cooling is resorted to for the same purpose.

Die-casting of Aluminum Bronze

The making of die-molds for aluminum bronze is becoming an art, as there are many things to be taken into consideration not necessary to provide for when making dies for the white metals. Foremost is the kind of metal to use for the dies to obtain the maximum number of castings. There is a choice of several materials possible, and it will depend largely upon the number of castings required, and their size, as to which material shall be given preference for the dies; thus where many thousands of castings are required of a given shape, the life of the die is a very important factor, and may overshadow all considerations of first cost. In this case, the best material to use for the dies is undoubtedly nichrome, although its first cost may be greater. For heavy castings, such as blank worm-gears for motor drive, cast iron is satisfactory, as the molds are a combination of metal and sand, and the metal part is quite simple to produce and, when worn out, is comparatively easy to replace. For small castings, a good grade of carbon steel will prove satisfactory. The position of the casting in the mold also calls for much study; sometimes an apparently insignificant casting will run well in a vertical position, but indifferently in a horizontal or oblique position. This point should be determined before the mold is commenced, and a very satisfactory way of doing this is to make test molds in blocks of graphitic carbon, as this material can be cut as readily as wood and has a chilling effect upon the metal a little greater than that of iron. The best method of gating, the position of the casting in the mold, and the size of the riser can all be determined before the metal die is made by the use of graphitic carbon, and it is a great convenience as well as an economy to do this, as the metal die cannot easily be changed after it has once been made wrong.

Removing Castings from Molds

It is important that an alloy, to be successful for die-casting purposes, shall not be fragile at a red heat and surface oxidize or scale. The ordinary foundry alloys—red brass and yellow brass—do not meet these requirements, which makes them very difficult to die-cast. It is necessary to remove the castings from the molds immediately after solidification, not only in the interests of production, but because of the difficulty of getting them out at all if they are left in too long. This is because the castings shrink on cooling, and, as the mold or die is rigid if the casting is left in until shrinkage is complete, it will grip the mold at one or more points and time will be consumed in removing it. If a metal is fragile at a red heat, it has to be handled very quickly to get it out of the die before it shrinks; otherwise it will crack, and if it is removed before contraction begins, it must be handled very gently or it will be broken by the operator. Then, should the metal oxidize when hot, the castings will turn black and will require to be cleaned by acids or mechanical means before shipment. Yellow brass also smokes the dies and in a short time an alloy of zinc and iron is formed, which roughens the walls of the die and causes the castings to adhere and produces hair cracks.

Composition of a Satisfactory Aluminum-bronze Alloy

Aluminum bronze, being free from all these defects, is a very suitable alloy for die-castings; in fact, it has no equal at present, although there is no telling what the future may bring forth. The difficulties encountered in making die-castings of the high melting point alloys are being overcome one by one, and there is little doubt that the bronze die-casting industry will become increasingly important. The alloy that appears to be most suitable for this purpose is composed approximately of copper, 88.50 per cent; aluminum, 10 per cent; and iron, 1.50 per cent. To make this alloy, the copper should be melted under a cover of charcoal produced by the charring of hard wood blocks on top of the metal, and when it is thoroughly liquid, the iron should be added in the form of tin-plate clippings, loosely coiled, which should be immersed in the copper as quickly as possible to avoid oxidation of the iron. After the iron, the aluminum should be added in small amounts, stirring the metal after each addition, and when the alloy is made it should be poured into ingots, and the ingots remelted for the castings, as the metal is better on the remelt than when first made.

The alloy with from 1 to 1.5 per cent iron has been used extensively for making worm-gears in place of phosphor-bronze. These gears are simply rings with lugs on the inner circle, and the object in using aluminum bronze was to get an alloy that would be ductile at a red heat, permitting the teeth to be rolled in the gear blank instead of being cut with machine tools. Many aluminum-bronze gears, however, are being cut and very few rolled at present.

High-tensile Aluminum Bronzes

The high-tensile aluminum bronzes contain from 3 to 10 per cent iron. A patent recently issued covers alloys containing from 3 to 5 per cent iron, 7 to 12 per cent aluminum, and the remainder copper. The alloy with 4 per cent iron and 10 per cent aluminum is a very strong metal; it has over 90,000 pounds per square inch tensile strength and good elongation. This alloy comes within the scope of the patent, but as just as good results can be obtained with over 5 per cent iron, this patent will have little, if any, effect upon the situation. The alloys having under 3 per cent iron do not come within the scope of the patent, and for the general run of aluminum-bronze castings, the low iron alloys are the ones most largely used.

As an engineering material, aluminum bronze containing up to 3 per cent iron and from 8 to 10 per cent aluminum will find extensive use for die-castings, gears, and miscellaneous castings of medium size where strong metals are wanted; and for airplane castings and other parts where the maximum strength possible in non-ferrous alloys is demanded, bronzes with iron content ranging from 5.25 per cent to 8 per cent, and aluminum from 7 to 10 per cent, will be most serviceable.

Making the Mark III Detonating Fuse

Second Installment of an Article Dealing with an Important Phase in Munition Manufacture

By EDWARD K. HAMMOND, Associate Editor of MACHINERY

IN the first installment of this article, published in the September number of MACHINERY, a general description of the Mark III detonating fuse was given. The machining operations on the body were also described. In the present installment, which concludes the article, the machining of the base, cap, and firing pin is described, the inspection methods are outlined, and the gages used for the inspection are dealt with.

Machine for Cutting Spanner Slots in Base

Milled in the base of each fuse there are two spanner slots of semicylindrical form, which are cut by cannon drills mounted in a special two-spindle auxiliary drill head on a Henry & Wright vertical drilling machine shown in Fig. 10. These drills are placed at such a distance between centers that they cut the two semicylindrical slots with the drills overlapping the edge of the work sufficiently so that the slots are cut in to just the required depth from the periphery. The machine is equipped with a special air-operated fixture for holding the work, which is automatically controlled by a collar carried on the drilling machine spindle. The same type of slide valve to which reference was made in connection with the description of the fuse body drilling machine illustrated in Fig. 8 (see page 31 of the September number) is used to actuate the work-holding fixture on this machine. This valve is contained in case *A*, and as the drilling machine spindle rises after completing an operation, a collar on the spindle pushes the valve up and releases the air pressure on the fixture so that the jaws can be opened through the action of a compression spring. A fresh piece of work is then put into place and the spindle fed down by means of the regular hand-lever. As soon as the collar on the spindle drops out of engagement with the push-rod on the valve, a spring contained in the case throws the valve over, which results in admitting air pressure to the piston contained in cylinder *B*, thus closing the jaws of the work-holding fixture so that they grip the work and hold it in place ready for the operation to be performed.

How Work-holding Fixture Operates

The work-holding fixture used on this machine is of interesting design. It consists of two sliding jaws between which the work is held. The left-hand jaw is directly connected to piston-rod *C;* and both the right- and left-hand jaws have compression springs behind them which tend to push both jaws outward as soon as the air pressure is released. The jaws are V-shaped, and when in the open position work *D* is dropped into place between them, after which the machine operator simply pulls down the feed-lever. Mention has already been made of the fact that as the drilling machine spindle starts down it trips the air valve, throwing pressure into cylinder *B* and causing the jaws of the work-holding fixture to shut. The way in which this is accomplished is as follows: The left-hand jaw is connected to piston-rod *C*, and as it is drawn over, this jaw carries the work with it; at the same time, movement of the left-hand jaw and of the work held between the jaws causes the right-hand jaw to be drawn inward against the tension of the compression spring behind it, until the inner jaw comes up against a stop. Then the air pressure acting on the piston to which the other jaw is connected becomes effective in holding the work in place for cutting the spanner slots.

Machine for Milling Slot in Firing Pins

At the inner end of the spiral *H* shown in the cross-sectional view of the fuse in Fig. 1 (see page 28 of the September number), there is a block carrying a spur which enters a slot milled in the firing pin. The purpose of this spur is to enable the spiral to grip the firing pin so that inertia cannot cause the entire spiral to slip aroung the body of the firing pin instead of rotating with the fuse. In Fig. 11 is shown a hand milling machine built by the Standard Engineering Co., of Providence, R. I., which is equipped for performing this slot milling operation. The job is a perfectly simple one, but attention is called to the fact that the machine is equipped with an air cylinder *A* and slide valve carried in case *B*, which

TABLE 2. MACHINING OPERATIONS ON BASE OF MARK III FUSE

Operation Number	Operation		Type of Machine	Type of Tool
1	1st Position	Form entire length and drill to depth of 1 inch	No. 53 National-Acme four-spindle automatic screw machine	Circular forming tool and stepped drill
	2nd Position	Drill small hole to full depth		Twist drill
	3rd Position	Ream both holes, shave end, and face		Stepped reamer, shaving and facing tools
	4th Position	Cut off		Cutting-off tool
2	Burr bottom of base		Cataract bench lathe	Facing tool
3	Mill spanner slots		Henry & Wright vertical drilling machine	Two-spindle auxiliary head and "cannon" (half-round) drills
4	Tap thread		Dalton bench lathe	Tap
5	Burr end of tapped hole		Goodell-Pratt polishing head	Burring tool
6	Buff		Goodell-Pratt polishing head	Felt wheel charged with emery

Machinery

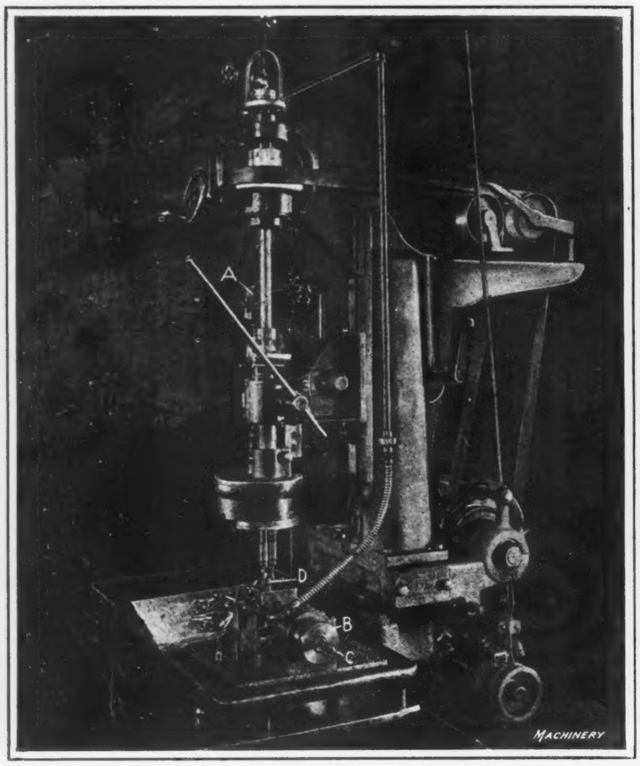


Fig. 10. Drilling Spanner Slots in Fuse Base. Drilling Machine is equipped with Special Two-spindle Head and Air-operated Work-holding Fixture

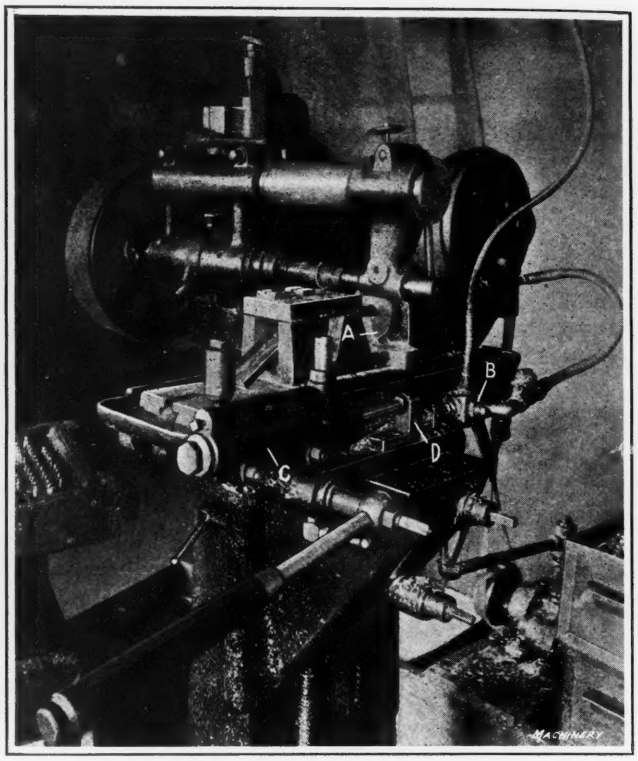


Fig. 11. Milling Slot in Firing Pin to receive Spur on Safety Spiral. An Air-operated Work-holding Fixture is provided, and Dashpot C prevents Operator from exceeding Maximum Safe Feed

actuate the work-holding fixture. The valve is of the type which has already been described, and trips are arranged on the milling machine table to actuate this valve to provide for automatically opening and closing the jaws of the work-holding fixture.

This fixture is arranged with grooves into which the small ends of the firing pin drop, and as the table is fed forward, air pressure is automatically admitted to cylinder *A*, which causes the sliding jaw of the fixture to move forward and push the work up against a stationary jaw, so that it is gripped on the two flanges. Inexperienced girl operators are employed on this work, and it was found that the desire to make as much money as possible under the piece-work schedule caused these girls to run the machines at a higher feed than the cutter and work could stand. This difficulty has been effectually overcome by equipping each machine with a dash-pot *C* filled with oil. The cylinder of this dashpot is attached to the table of the milling machine and the piston-rod is connected with a bracket *D* secured to the machine frame. As the table is fed forward, the dashpot makes it impossible to employ a higher rate of feed than the cutter and work will stand, the opening in the dashpot being carefully adjusted so that the machine cannot be used beyond the maximum feed that should be employed on the operation.

Spinning Head onto Firing Pin

Doubtless it has been noted from the schedule of operations, Table 4, that the body and head of the firing pins are produced on automatic screw machines. After the slot has been milled in the firing pins, the next step is to assemble the heads and pins together, and for this purpose use is made of Greenerd arbor presses. The diameter of the pilot on the pin which enters the hole in the head is so proportioned that these two members can just be pushed together by the arbor press, and in so doing the press turns down a slight burr on the top of the pin which prevents the head from coming off

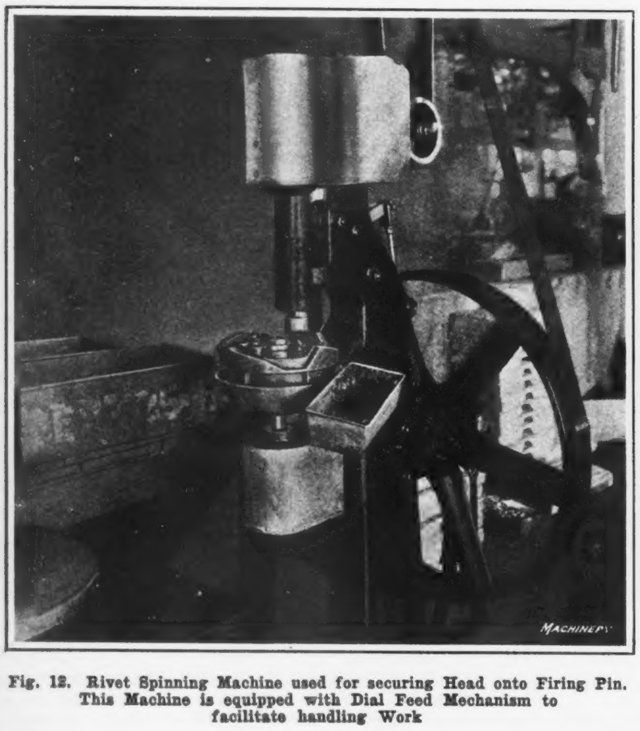


Fig. 12. Rivet Spinning Machine used for securing Head onto Firing Pin. This Machine is equipped with Dial Feed Mechanism to facilitate handling Work

Fig. 13. Milling Points on Firing Pins. Rollers B hold Work down against Pressure of Cut, and Levers C lift Heads of Work to facilitate Removal from Fixture

until the subsequent operation is performed. The final work of securing the head and pin together is accomplished on a rivet spinning machine built by the Grant Machine & Mfg. Co., of Bridgeport, Conn. As shown in Fig. 12, this machine is equipped with a dial feed which enables the operator to remove finished pieces and substitute fresh pins ready for the spinning operation, while the machine is at work on one of the firing pins held in the dial, so that the machine and operator are both kept constantly employed. It will be seen that the dial is arranged to carry four pins held in collet chucks; to adapt the machine for the use of this dial feed it was necessary to furnish a special mechanism for indexing the plate, locking it in position during the time that the spinning operation is taking place, and opening and closing the collets.

Milling Points on Firing Pins

Four sharp points are required on the end of the firing pin that strikes the fulminate cap in the fuse; and an ingenious special machine which is equipped with dial feed has been developed for use in milling these points. This machine, which is shown in Fig. 13, was especially designed to meet the peculiar requirements of the work and has been the means of enabling an unusually high rate of production to be secured. The points on the firing pins are of such form that they are produced by milling off the sides of the pin at the point to give it a square form and then cutting two notches across the end which are at right angles to each other. The desired result is obtained by having two gangs of two milling cutters placed at right angles to each other, so that as the dial rotates it first carries the end of each firing pin between one pair of cutters which mill two sides of the square and cut one notch; and then, after the dial has made a quarter revolution, the end of the pin passes between the second pair of cutters which completes the milling operation. All that the operator has to do is to drop the pins into holes in the dial and then remove the milled pins after the dial has made one complete revolution. One pair of milling cutters is partially shown at *A* and as the point of each pin comes between each pair of milling cutters, its head passes under a roller *B* which holds the work down against the pressure of the cut. It will be seen that at each hole in the dial there is a small pivoted lever *C* which is inclined upward. The lower end of this lever extends under the head of the firing pin, and at the side of the dial nearest the operator there is a bridge under which these pivoted levers pass, with the result that the inclined end of each lever is pushed downward, causing the firing pins to be lifted from the dial sufficiently so that they may be easily removed and fresh blanks substituted.

Methods of Inspection and Checking Production

In one of the introductory paragraphs mention was made of the fact that after each machining operation is performed the work is given a 100 per cent inspection before being sent to the machine on which the next operation is performed. The way in which the details of this plan are worked out varies according to the condition of the work and other determining factors. In the case of automatic screw machines working on brass parts, each part is gaged at the machine and those pieces which pass inspection satisfactorily are put in horizontal trays with spaces for fifty fuse bodies or bases, so that they are ready to be sent on to the next department. In Fig. 15 is shown a view of the inspection bench at the back of one of the automatic screw machines, and such provision for the inspection of the product is made on each of the automatic screw machines which are working on brass parts. There is an inspector employed at each machine, and as fast as the pieces are finished they run through a chute which delivers them onto the inspection bench. Each piece is then gone over with limit gages to see that all dimensions are satisfactory, and if so, it goes into the tray for O. K.'d work. The value of this method of inspecting the work right at the machine is that in the event of anything going wrong with the tool setting, the trouble can at once be corrected before a lot of expensive brass stock has been spoiled. It will be understood that by inspecting the work after each operation, there is no loss of time involved in performing subsequent machining operations on defective parts.

Whenever a piece is found to be defective in some respect, this piece goes into the inclined tray shown in the illustration, which, it will be seen, has rows of holes marked with the different classes of errors which may exist in the work. In this way, all defective parts may be properly classified before they are sent to the reclaiming department. When a tray of these defective parts is sent upstairs to be reclaimed, the employes in the department see at a glance what is the matter with each piece, and the work is then distributed to the different operators whose duty it is to correct different classes of errors. After pieces have been reclaimed in this way they are placed in the standard form of trays with spaces for fifty parts. Then, when a tray has been filled to its capacity, it is sent downstairs and merged with the regular product, so that it may go on with the subsequent operations, to completion.

TABLE 3. MACHINING OPERATIONS ON CAP OF MARK III FUSE

Operation Number	Operation	Type of Machine	Type of Tool
1	1st Position — Form entire length and rough-drill	No. 55 National-Acme four-spindle automatic screw machine	Forming tool and twist drill
	2nd Position — Finish-drill and face		Stepped drill with facing tool
	3rd Position — Drill small hole to depth		Twist drill
	4th Position — Ream both holes and cut off		Stepped reamer and cutting-off tool
2	Burr inside of large-diameter hole	Cataract bench lathe	Burring tool
3	Tap thread	Henry & Wright vertical drilling machine	Errington tapping attachment
4	Burr top of tapped hole	Goodell-Pratt polishing head	Burring tool
5	Drill cross-hole	Leland-Gifford sensitive bench drilling machine	Twist drill
6	Ream inside to remove burrs produced in cross-drilling	Special machine	Reamer
7	Burr top of small-diameter hole	Leland-Gifford drilling machine	Burring tool
8	Zinc plate	Special plating bath	Electrodes and plating solution

Machinery

Inspection of Steel Parts Produced on Automatic Screw Machines

In inspecting the product of automatic screw machines used for making fuse caps and parts of the firing pin, which are machined from cold-drawn steel bars, the method of procedure in carrying on the work is different, owing to the lower cost of the raw material from which these parts are made. In these cases it is not considered advisable to have an inspector stationed at each machine, because the value of the material would not be sufficiently high, in the event of any trouble in the tooling producing a considerable amount of defective work, to result in a loss which would assume sufficient proportions to warrant paying the wages of an inspector who is kept constantly looking after the work of one machine. At the same time, precautions are taken to guard against the occurrence of errors as far as possible. This is done by having one inspector stationed in the automatic screw machine department in which steel parts are made. It is the duty of this man to go around from machine to machine and pick up pieces at random, which are gaged to see that they meet all requirements.

This inspector keeps on making rounds of the department, and as soon as he finds any defective work, the machine on which such work was produced is at once stopped, pending an investigation to see if anything is wrong with the setting of tools, and if so, to correct the trouble before further material is spoiled. The work of this inspector is carried on merely to guard against the production of defective work before it reaches the main inspection department where all of the steel parts produced on automatic screw machines are given a 100 per cent inspection. This work is done by women who sit at a long bench, shown in Fig. 14, down which the work is passed from inspector to inspector. Each inspector has gages for determining the accuracy of certain dimensions, and in this way the pieces can be passed along very rapidly. What has been said in regard to giving all of the work produced on automatic screw machines a 100 per cent inspection before it goes on to the next department, is true in the case of all subsequent machining operations. In every case the work performed during any operation is thoroughly checked up to make quite sure that there is no defect in dimensions or workmanship which would prevent the part from assembling properly with other parts of the fuse, or in any other way result in making the part unsuitable for giving efficient service.

Gages for Fuse Bodies

In Fig. 15 is shown the set of gages provided on each automatic screw machine for use in the inspection of fuse bodies produced on that machine; and an explanation has already been given of the way in which each brass piece produced on automatic screw machines is given a 100 per cent inspection before being sent to the machine on which the next operation is performed. The gages used for testing bodies consist of a pair of "Go" and "Not Go" plug gages *A* which are used for testing the diameter of the pocket drilled at the head end of the fuse body. Next comes a pair of "Go" and "Not Go" gages *B* which are used to measure the over-all length. These gages are furnished with little cradles in which the work is laid so that the ends may come between the gaging points. At *C* there is a similar pair of gages that is used for testing the length between the shoulders at each end of the fuse body, against which the cap and the base will abut when these parts are assembled onto the body. For measuring the form of the work from the shoulder under the large diameter of the body to the base end of the body, there is a pair of "Go" and "Not Go" contour gages *D*; and at *E*, *F*, and *G* there are shown three Johansson "Go" and "Not Go" snap gages that are used for measuring the diameters of the three cylindrical surfaces on which threads are to be milled during subsequent operations.

TABLE 4. MACHINING OPERATIONS ON FIRING PIN OF MARK III FUSE

Operation Number	Operation		Type of Machine	Type of Tool
1	1st Position	Rough-turn	No. 52 National-Acme four-spindle automatic screw machine	Circular forming tool and box-tool
	2nd Position	Finish-turn pin		Box-tool
	3rd Position	Shave four large diameters to length		Shaving tool
	4th Position	Cut off		Cutting-off tool
2	Mill keyway to receive spur on safety spiral		Standard hand milling machine	Milling cutter and dashpot to control feed
3	Assemble head on firing pin		Greenerd hand arbor press	
4	Spin head on firing pin		Grant rivet spinning machine	
5	Drill cross-hole		Leland-Gifford sensitive bench drilling machine	No. 40 twist drill
6	Zinc plate		Special plating bath	Electrodes and plating solution
7	Mill points on firing pin		Special milling machine	Milling cutters
8	Clean and lacquer points			Wire brush
	FIRING-PIN HEAD			
1	1st Position	Form two heads and center	No. 53 National-Acme four-spindle automatic screw machine	Circular forming tool and center drill
	2nd Position	Drill hole through two heads		Twist drill
	3rd Position	Ream hole through two heads and cut off one		Reamer and cutting-off tool
	4th Position	Countersink and cut off		Countersink and cutting-off tool
2	Counterbore hole on under side		Leland-Gifford drilling machine	Counterboring tool

Machinery

Gages for Testing Fuse Bases

In Fig. 16 is shown the complete set of gages which is used for testing the fuse bases to see that they fulfill all requirements. These gages are of the "Go" and "Not Go" type, so that they show that the work comes between the required limits. At *A* is shown a gage used to measure the over-all length of the base, and it will be seen that the upper arm of this gage is ground to two different levels, so that the work must go between the upper level and the base as shown, but must not be short enough to enter the "Not Go" section. Snap gages *B* and *C* are the familiar Johansson limit type and they are used for measuring the small and large diameters of the base, respectively. Gage *D* is employed to test the accuracy of the height of the large section of the base. In order to be satisfactory, the work must go under arm *a*, but must not go under *b*. The plug gages shown at *E* are "Go" and "Not Go" gages for determining the size of the small inside diameter of the fuse base.

At *F* are shown "Go" and "Not Go" thread gages for testing the thread inside the base, and gage *G* is used for testing the concentricity of the inside and outside of the base. The work is pushed over the two smaller diameters of this plug gage so that the bottom of the gage comes up against the face of the work, after which the work is slowly revolved. The large outside diameter is equal to the large diameter of this plug gage, so that any lack of concentricity will be revealed by the outside of the work either overlapping or failing to reach the periphery of this large diameter on the gage when it is tested.

The gages *H* and *I* are used for testing the depth of the large and small diameters inside the base. For this purpose the work is slipped over the plug on the gage which is a sliding fit inside the knurled ring. This ring is ground to an accurate finish on its top surface with one half of the surface ground to a higher level than the other half. The difference in height of these two surfaces represents the limits between which the depth of the work must come. In using the gage to test the accuracy of the work, the inspector slides his finger across the top of the plug with the view of determining that the end of the plug is higher than the lower surface ground on the face of the ring, but lower than the higher surface ground on this ring.

Gages for Inspecting Cap

In Fig. 17 there are shown gages used for inspecting the fuse cap to determine the accuracy of all dimensions. Plug gages *A* are "Go" and "Not Go" gages for the large inside diameter, and gages *B* are for the small inside diameter. At *C* and *D* are shown two "Go" and "Not Go" Johansson snap gages for measuring the two outside diameters of the work. At *E* is shown a "Go" and "Not Go" height gage similar to that shown at *A* in Fig. 16 for measuring the height of the base, and at *F* are "Go" and "Not Go" thread gages for the threaded inside diameter of the cap which screws onto the fuse body. Gage *G* contained in the glass case is used for determining the accuracy of the position of the cross-hole drilled through the cap in relation to the bottom of the cap. When using this gage, pin *H* is slipped through the hole in the work, after which the work is pushed over plunger *a* on gage *G*. The work is pushed up against the gage so that cross-pin *H* engages the plunger and causes needle *b* to move over the dial of the gage. If the location of the cross-hole in the fuse cap comes within the required limits of accuracy, needle *b* will come to rest at some point between points *c* and *d*.

At *I* there is shown a gage used for measuring the depth from the base of the cap to the bottom of the large inside diameter. The upper surface of this ring gage is ground with the two halves at different levels, and the plug which enters the work is slidably fitted in the ring. In using the gage, the upper end of this plug, when the lower end of the plug is in contact with the work, must be above the lower ground surface on the top of the ring gage and below the upper surface. Gage *J* is used for determining the accuracy of the location of the cross-hole drilled in the fuse cap in relation to the top of this cap. The work is dropped into the grooves in the gage so that pins *e* and *f* are properly situated to enter the cross-hole. If the hole is properly located in the work, pin *e* must go into the hole, but pin *f* must not go into the hole in the work when the end of the work is in contact with the plate at the bottom of the gage.

Fig. 14. Inspection Bench on which All Steel Parts of Fuse are given a 100 Per Cent Inspection in Order that Defective Parts may be rejected before Subsequent Work is done on them

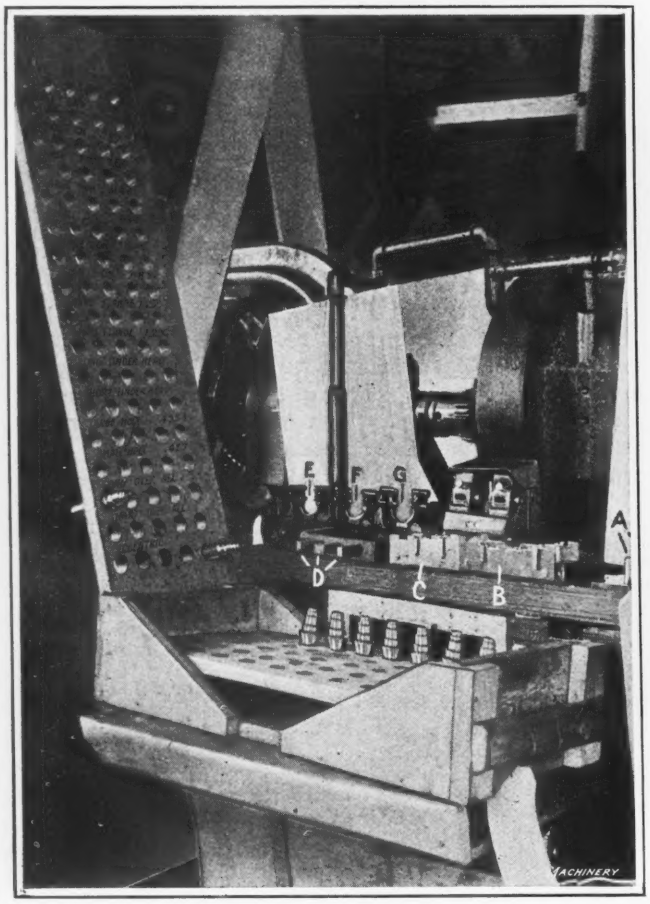


Fig. 15. Arrangement of Gages and Rejection Board on Automatic Screw Machine

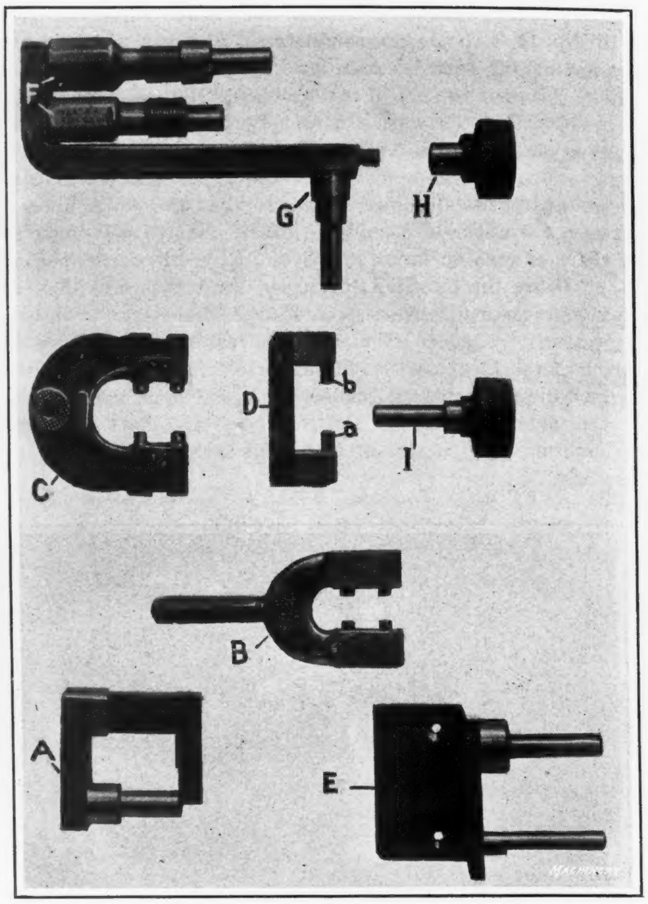


Fig. 16. Set of "Go" and "Not Go" Type of Gages used for checking Dimensions of Fuse Base

Gages for Firing Pin

There are two parts of the firing pin to be gaged, namely, the pin and the head which is assembled onto this pin. Four diameters on the pin have to be accurate—that is to say, all diameters except that of the section around which the spiral is wound. These diameters are tested with Johansson snap gages shown at *A*, *B*, *C*, and *D* in Fig 18. After this has been done, it is required to test the over-all length of the pins, and for this purpose use is made of "Go" and "Not Go" gages shown at *E* and *F*. It will be seen that each of these gages is furnished with a small cradle *a* onto which the firing point to be tested is dropped. The cradle is supported by a compression spring so that the pin may be pushed down into the gage and then released, with the result that the spring raises the cradle and lifts the pin up to a point where it can be easily picked up by the inspector. These gages *E* and *F* are of the "Go" and "Not Go" types, so that the work must drop through one gage, but fail to pass through the other.

The gaging operations on the pins are completed by the gages which have just been described, and the remaining gages shown in Fig. 18 are used for determining the accuracy of the dimensions of the head of the firing pin. At *G* is shown

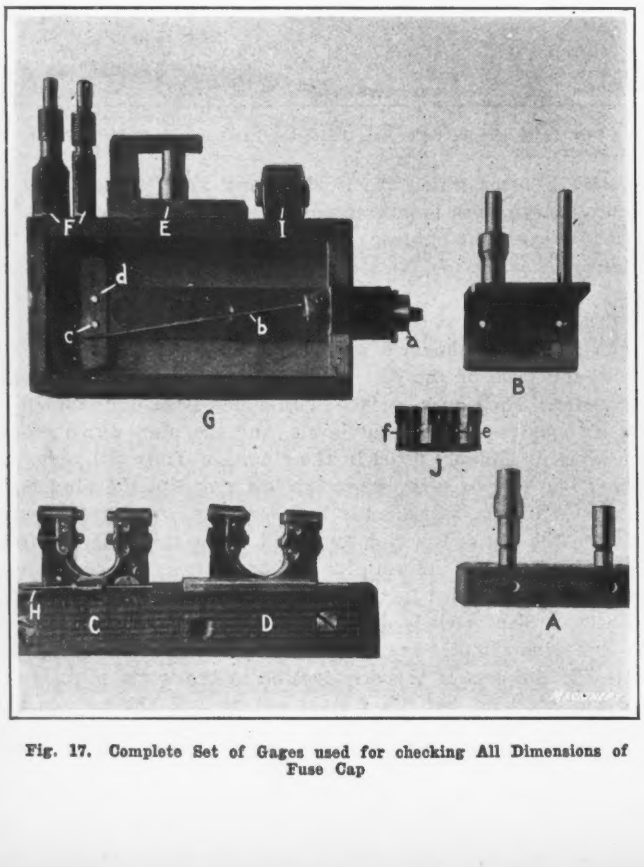


Fig. 17. Complete Set of Gages used for checking All Dimensions of Fuse Cap

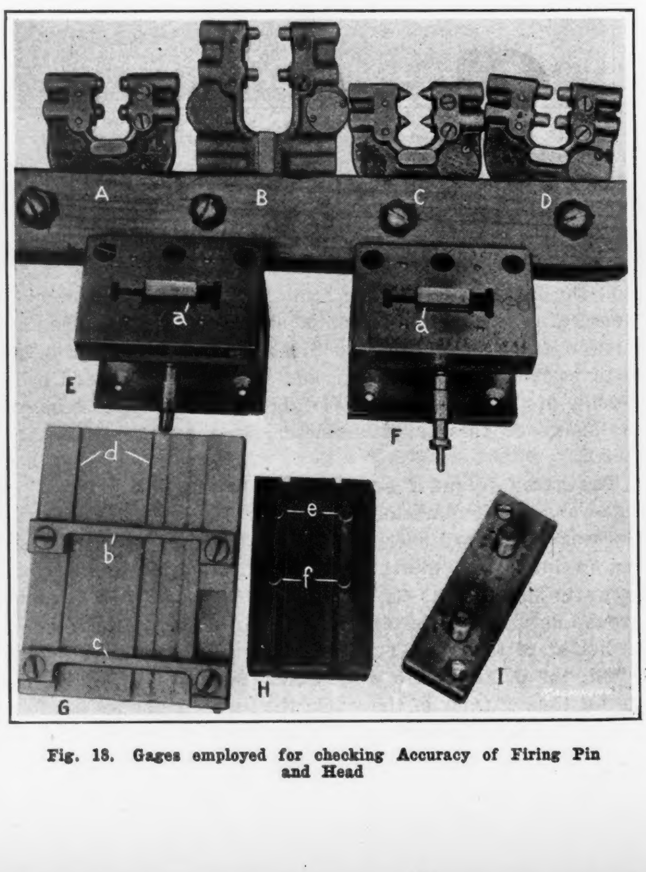


Fig. 18. Gages employed for checking Accuracy of Firing Pin and Head

Fig. 19. View of Assembling Department where Fuse Parts are put together prior to giving Assembled Fuse a General Visual Inspection

a "Go" and "Not Go" gage used for determining the accuracy of the height of the head. This gage is furnished with two bridges *b* and *c* and the heads to be tested are pushed down a slide *d*. If the height is correct, the head must go under bridge *b* but fail to pass under bridge *c*. The next test is to determine the accuracy of the outside of the diameter of the head, for which purpose gage *H* is employed. Heads with a diameter which comes within the required limits of accuracy must pass between pins *e* but fail to pass between pins *f*. The final test on the heads consists of determining the accuracy of the diameter of the hole into which the top of the firing pin is entered in assembling the head onto the pin, the familiar form of "Go" and "Not Go" plug gages shown at *I* being used for this purpose.

Assembling Finished Parts into Fuses

After the machining operations and inspection have been completed on each part, those parts which have passed all inspection tests are sent to the assembling department. Reference to Fig. 4 on page 29 of the September number, will show that this department is shaped somewhat like a letter L. There are two long tables which run up the main section of this department and here the bodies and bases of the fuses are assembled together. It will also be seen that there are two tables running across the shorter arm of the department, and on these tables the parts of the firing pins are assembled together, after which the assembled firing pins are placed in the caps and the two parts are secured together by means of the safety pin indicated at *E* in Fig. 1. After the work of assembling these two parts has been completed, the assembled caps and firing pins are transferred to the main section of the assembling department and screwed onto the body of the fuse. In Fig. 4, the arrows indicate the way in which work travels through the two sections of the assembling department, and also the manner in which the assembled caps and firing pins are merged with the work which is being assembled on the long tables in the main section of this department. Fig. 19 shows a general view in the assembling department.

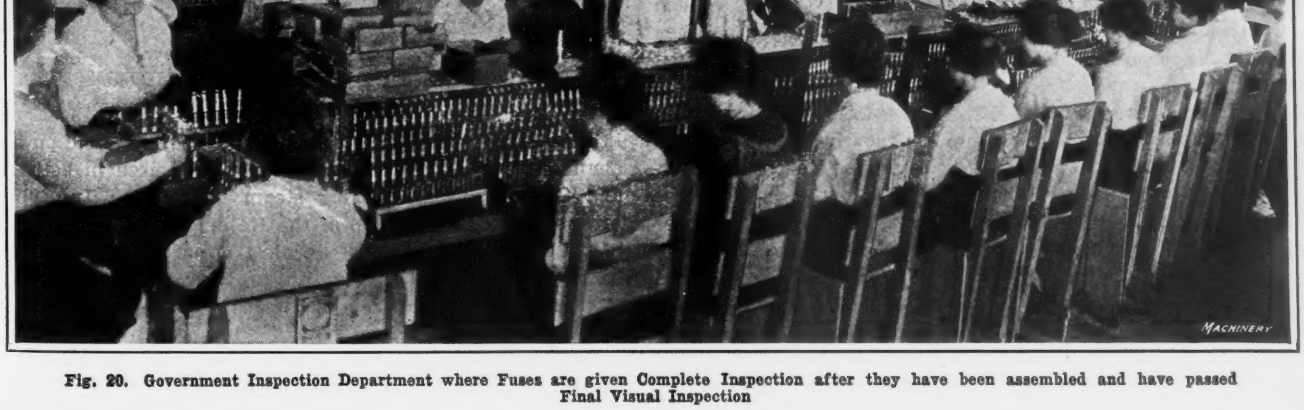


Fig. 20. Government Inspection Department where Fuses are given Complete Inspection after they have been assembled and have passed Final Visual Inspection

General Visual Inspection

After the fuses have been assembled, they are given a complete visual inspection, the idea being to detect any defects which might have escaped the inspectors who have been checking up the perfection of workmanship on each of the operations which were performed in manufacturing the various parts. The work is taken out of the assembling department and carried over to the bench indicated in Fig. 4, and here each fuse is carefully examined with the view of making sure that all parts fit together properly and that there are no parts machined from cracked stock, which have escaped the vigilance of previous inspectors. Two of the important duties of the employes of this department are to see that threaded parts assemble without trouble from lack of concentricity of the threads on the individual parts, and also that there are no burrs or other obstructions in the threads or on shoulders which prevent the pieces from screwing together as they should.

Government Inspection

Fuses which have been accepted by all of the inspectors of the International Steel & Ordnance Co. are now transferred from the department in which they are given the complete visual inspection to a separate room, shown in Fig. 20, in which the government inspectors work. This department is in charge of a chief government inspector who reports to a United States Army officer with the rank of first lieutenant, who is also stationed at the plant. The government inspectors take the fuses apart and go over each individual part to see that it is satisfactory and that all parts on each fuse assemble together in the way they should. After this work has been completed, the fuses are reassembled and sent to four power presses, equipped with dies used for placing the required marking on the fuses. One of these presses is shown in Fig. 21.

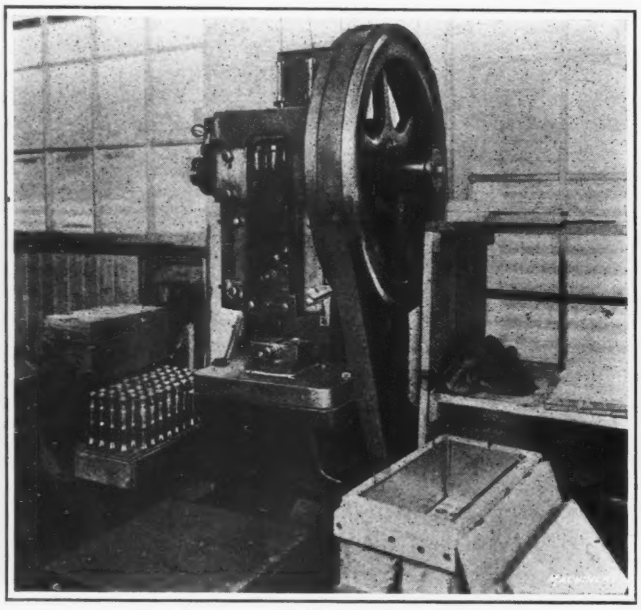


Fig. 21. Fuses that are passed by Government Inspectors are marked under Power Press equipped with Suitable Dies. These Fuses are then packed in a Tin-lined Wooden Box Ready for Shipment

The marked fuses are then assembled in racks furnished with an individual compartment for each fuse, and these racks are placed in a tin box, which, in turn, is put into a wooden box in which the fuses are shipped to the loading plant. When the box has been filled (each box holds fifty fuses), it is put on a roller conveyor that carries it down to the freight car for shipment, as shown in Fig. 22. After they have been loaded, the fuses are put back into the rack in the tin box and the cover is soldered onto this box to make it entirely waterproof, after which the tin box is placed in the wooden case and sealed up for shipment to the battlefield. The tin boxes are furnished with a key similar to that used for opening various forms of tins in which corned beef and other food products are packed; this key is secured to the loose end of a strip of tin which runs all around the side of the box near the top, making it an easy matter to open the box and take out the fuses and assemble them with the shells for use.

QUIETING WORN GEARS

The question of the suitability of ground cork as a quieting agent for noisy epicyclic gearing brings to mind several peculiar methods that were employed a few years ago to eliminate the noisy humming of worn-out gears. The mixing of a liberal quantity of sawdust with the lubricant was one method, while another was the filling of the gear-box with shavings of the sort used for packing fragile goods, the usual lubricant, of course, being allowed to remain.

These materials were supposed to act as a cushion between the teeth of the gears, thus reducing the shock which set up the objectionable humming and vibration. Cork, being a much more elastic material than sawdust, ought to be more efficient for the purpose. Ground rubber might be even better but for the fact that it would soon form a semi-fluid mass by reason of the action of the oil upon it, a fault which would not be found with cork, although any medium would ultimately lose its properties by being finely ground. There is some evidence that the plan of introducing sawdust, etc., into the gear-box is at least temporarily effective. It is not unknown to some of those who prepare second-hand cars for sale; and even public service vehicles have managed to pass a silence test by this means.

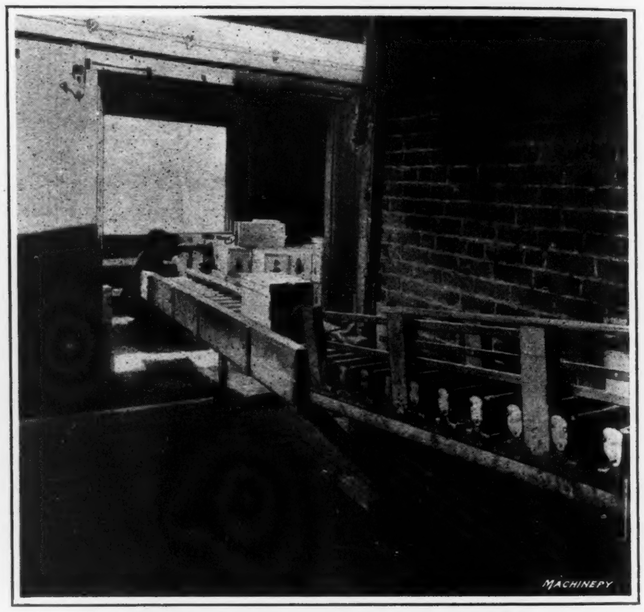


Fig. 22. A Conveyor will be seen beside the Power Press in Fig. 21. Filled Boxes are pushed onto Conveyor and run down into Car in which they are shipped to Loading Plant

It may be asked what, if any, objections there are to the plan. There does not seem to be an obvious reason why it should cause mechanical injury to the gearing, providing that no solid matter is introduced, such as pieces of metal, which would jam the gear, but there is at least one serious objection of another sort, namely, great waste of power by friction due to the churning up of the semi-plastic mass by the gear teeth; the gear-box would, in fact, be acting as a continuous brake. There is also the difficulty of the proper lubrication of the gear shafts and bearings. The former would very likely make itself felt by causing stiffness in the operation of changing the gears. M. E.

* * *

AN ELECTRIC STEAM BOILER

An unusual application of electric energy has been made in the Alpine regions of Europe where hydro-electric power is abundant but coal scarce. Electric heat is used in both Italy and Switzerland for raising steam in boilers. In a boiler invented by Colonel Revel of the Italian Army, the resistance of water to the passage of an electric current is utilized for heating the water. According to the *Scientific American*, alternating current of from 200 to 3600 volts is employed. The production of steam is regulated automatically and requires no attention. This "electric steam boiler" may be used at any pressure up to 200 pounds per square inch.

PROTECTING IRON FROM CORROSION

BY MARK MEREDITH[1]

In a paper read before the British Iron and Steel Institute, J. N. Friend summarized as follows the results of his researches on the usefulness of paint for protecting ironwork from atmospheric corrosion:

The practical value of acceleration tests is very small in the present state of the knowledge on the subject. Reliable results can be obtained only from tests carried out under conditions like those prevailing in practice.

The addition of pigment to oil increases the efficiency of the latter as a protective paint until a maximum is reached; after this, further addition of pigment causes deterioration. The best results are obtainable from paints possessing as high a percentage of good oil as is compatible with good body and any other working property that has to be considered.

Linseed oil, on setting, expands about 3.3 per cent; this is the primary cause of crinkling. Further oxidation causes a decrease in volume, which, in time, leads to cracking.

Linoxyn is permeable to moisture; the permeability is reduced by heating in absence of air, when the oil increases in density, viscosity, and molecular weight.

Polymerized linseed oil affords a better protection than raw oil when used as a paint vehicle.

The functions of a pigment are to toughen the film and render it less permeable to water, vapor, and oxygen; it also reduces the expansion of the oil on setting, and thus minimizes the tendency to crinkle.

A thick coat of paint protects the underlying metal more efficiently than a thin coat, provided the coat is not so thick that running or crinkling takes place.

The very best results are obtained, however, by multiple coats; two thin coats are better than one thick one of equal weight.

Thinners enable thin coats of paint to be applied; turpentine leaves a very slight residue upon evaporation, but its effect on the efficiency of the paint is small.

The most permanent paints are those containing black or red pigments, for these absorb the shorter rays of light and prevent them from hastening the destructive oxidation of the linoxyn by the air.

Finer pigments afford more efficient protection than coarse pigments, as they are more thoroughly in contact with the oil.

Iron structures should be painted while their scale is still on, after loosely adherent flakes and rust have been scraped off. The paint will last longer than if applied to the pickled or sand-blasted surface and the labor of removing the scale is saved.

Experiments with rusty plates are not conclusive, but suggest that the rust need not be so carefully removed, prior to painting, as is usually thought to be necessary.

* * *

It is stated that the production of emery, corundum, and artificial abrasives in 1917 increased 33 per cent in quantity and 172 per cent in value over that of 1916.

[1]Address: 67 Dale St., Liverpool, England.

Fig. 1. Sine-bar Fixture for Precision Angular Work

SINE-BAR FIXTURE

A sine-bar fixture which is more convenient to use in many cases than the ordinary sine-bar is illustrated in Figs. 1 and 3 and in detail in Fig. 4. Different views of the fixture are shown in Fig. 1; the view to the right illustrates it without the brace bars or the guiding plate. The brace bars serve to hold the swinging leaf or arm rigidly in any angular position, if some light drilling or milling, etc., should have to be done directly on work attached to the fixture; otherwise the friction between the joints of the two main members of the bar and between the worm and worm-gear is ample to hold the set position of the bar. The guiding plate may be attached to either side of the leaf and serves to hold the parts in alignment. The two parallel strips seen below the left-hand view are inserted under the work which must be supported upon strips instead of being placed directly upon the leaf of the fixture. This leaf is adjusted by worm-gearing, as shown in Fig. 3.

The formulas required for setting the fixture are stamped on brass plates which are attached to each side of the base. Detailed views of these plates are shown in Fig. 2. In addition to the formulas, each plate has marked on it a simple dia-

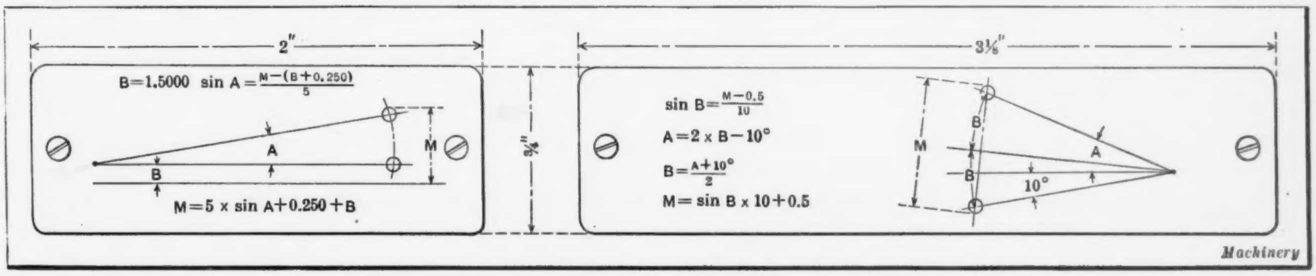


Fig. 2. Formula Plates which are attached to Sides of Sine-bar Fixture

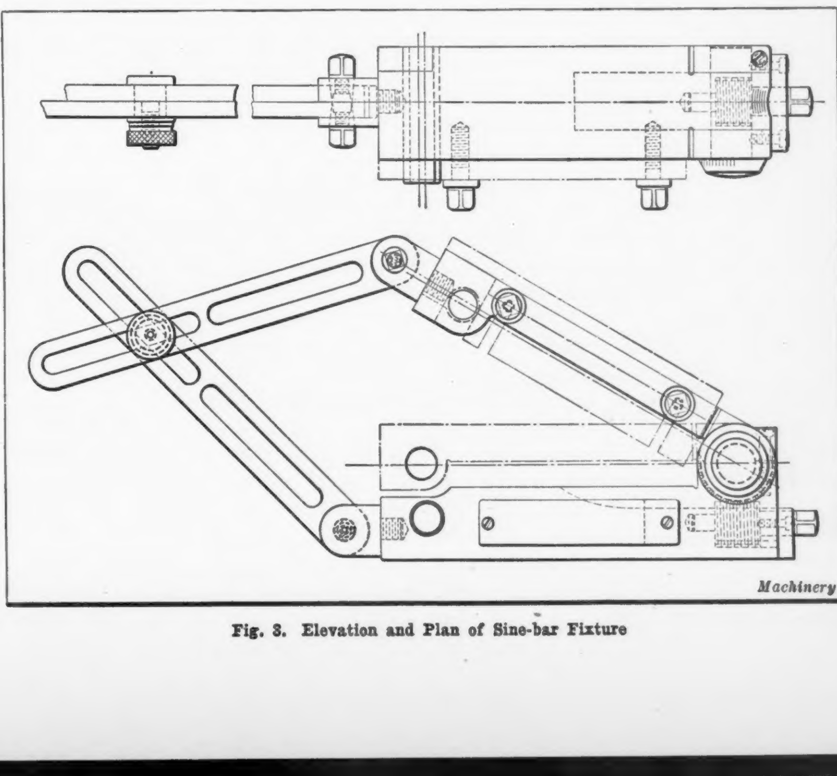


Fig. 3. Elevation and Plan of Sine-bar Fixture

gram illustrating the dimensions represented by the different letters. On the plate at the left, M equals the distance from the under side of the fixture base to the top of the measuring plug on the leaf, A equals the angle between the leaf and the base, and B equals the distance from the under side of the base to the center of the pin about which the leaf swings. The sine of $A = \frac{M - (B + 0.250)}{5}$. The height M from the lower side of the base to the top of the plug equals $5 \times \sin A + 0.250 + B$. This height M would be required when setting the leaf to a given angle A by means of a height gage or other measuring instrument used for the purpose.

If a micrometer or vernier caliper were used, the distance over the plugs would be required. As shown by the view to

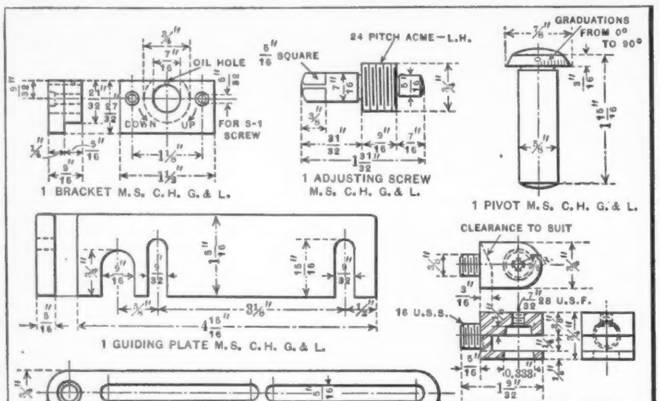
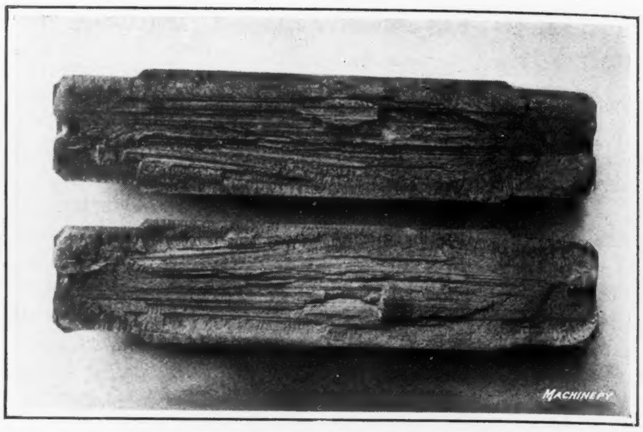


Fig. 4. Details of Sine-bar Fixture

the right, Fig. 1, one plug projects from the side of the leaf and the other from the base. On the plate illustrated at the right in Fig. 2 are given the different formulas and also a diagram indicating the meaning of the different letters. The distance M from the outside of one plug to the outside of the other equals $\sin B \times 10 + 0.5$. The angle A represents the angle between the leaf and the base of the fixture. Angle B for any angle A equals $\frac{A + 10 \text{ degrees}}{2}$. The angle of 10 degrees marked on the diagram represents the angle between a horizontal line intersecting the axis of the leaf pivot and a line passing through the center of this pivot and the center of the lower measuring plug. This sine-bar fixture was designed by the Small Tool Department of Pratt & Whitney Co., Hartford, Conn., and it is a type used by this company for precision angular work.



An Example of Very Defective Tool Steel

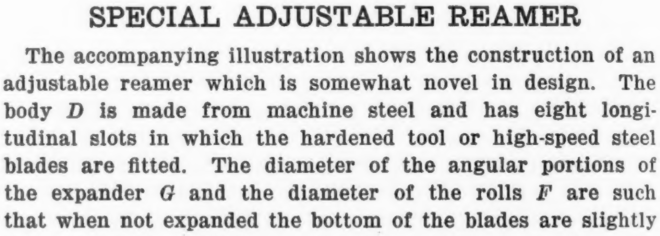
EXAMPLE OF DEFECTIVE TOOL STEEL

In the accompanying illustration is shown an interesting example of defective tool steel. The defect in the steel is probably due to piping, which is caused by contraction when cooling, in the top half of the ingot. This defect causes tools to split from the center in hardening. In most cases when a pipe exists in the ingot it does not weld together in the rolling process. Therefore, tools should not be made from steel that is taken from the top section of the ingot when it is desired to insure against any possible defect in the finished tool.

* * *

SPECIAL ADJUSTABLE REAMER

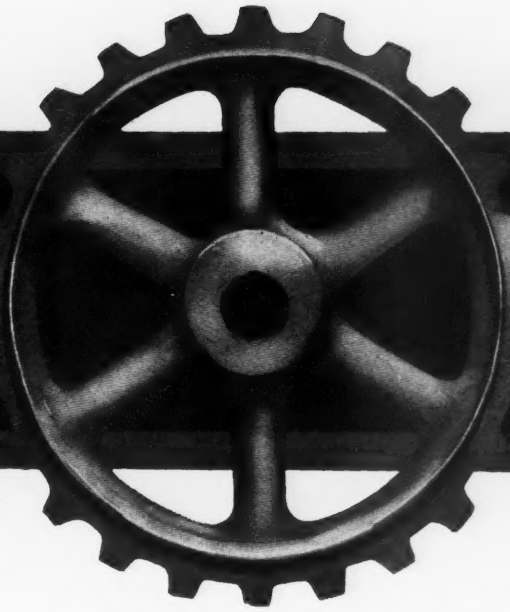
The accompanying illustration shows the construction of an adjustable reamer which is somewhat novel in design. The body D is made from machine steel and has eight longitudinal slots in which the hardened tool or high-speed steel blades are fitted. The diameter of the angular portions of the expander G and the diameter of the rolls F are such that when not expanded the bottom of the blades are slightly lifted from the bottom of the slots and rest on the rolls. Hence, while the slots must be milled accurately as to parallelism with the axis, no great accuracy is required as to depth. The blades E are ground all over and can be, of course, of any length required and either straight or tapered. The body D is peened slightly at each side of the slots with the blades in place, so that they are given a slight drive fit in the slots. The expander G is made from machine steel, casehardened and accurately ground to fit the reamed hole in body D at point J. The tool steel rollers F are hardened and ground to exactly the same size, to give equal expansion, the angular portions of the expander also being ground with equal taper so as to produce uniform expansion. The rollers F fit into slots that are the same width as the blade slots, but of a length equal to the diameter of the rollers plus a slight uniform clearance. These slots are cut through the portion of the body D between the bottom of the blade slots and the hole in which the expander fits. The



Adjustable Reamer

collar K is fitted to the body D as shown, and serves as a stop for the blades. When the expander G is screwed out, the accurately ground tapered portions force the rollers F away from the center, and thus cause the blades E to expand uniformly. The grinding of the reamer is done with the expander rollers and blades in place. This reamer has proved more accurate after expanding than the usual type of expansion and adjustable reamers.

Sprocket Design Theory and Practice



Factors Controlling Designing of Sprockets for Malleable Chain Drives, and Action of Chain on Driving and Driven Sprockets under Different Conditions

BY WILEY M. FREE[1]

WHEN the writer was called upon to design a sprocket for malleable chain, a search of text-books and handbooks for formulas and data on this subject indicated that apparently no authority had ever taken enough interest in the subject to formulate any definite rule for the design of sprockets. An article on the "Design and Construction of Sprockets," published in the January, 1916, number of MACHINERY, is a comprehensive study of the subject. The information contained in this article has been given a thoroughly practical test, and while the theory is correct, a sprocket designed by the formula given is not satisfactory in practice, due to inaccuracies of the chain and sprocket.

Fig. 1 is a diagram of a theoretically correct sprocket for malleable chain, designed according to the formula referred to, and it will work perfectly either as a *driver* or a *driven*, provided both the chain and the sprocket are absolutely accurate. The formula is based on the rule for inscribed polygons, the length of the sides of the polygon being the pitch of the chain for which the sprocket is constructed. According to this formula, the pitch diameter D of the sprocket is found by dividing the pitch p of the chain (which is also the chord pitch P of the sprocket) by the sine of one-half the angle A. The root diameter R is then found by subtracting twice the dedendum of the chain (or the distance from the center of the chain to the back of the block) from the pitch diameter. The outside diameter O is equal to the pitch diameter D plus twice the dedendum d of the chain (see Fig. 2). The width of the tooth W is next laid off on the pitch circle and equals 0.8 of the distance between the blocks of the chain as indicated at L in Fig. 2. The radius for the base circle B is 0.47 of the pitch diameter. The face radius F, or the radius forming the face of the tooth, equals 0.17 of the pitch diameter, except that the minimum face radius shall not be less than the pitch p of the chain minus the dedendum. It will be found necessary in most cases to use this minimum radius up to and including sprockets with 14 teeth. The root radius r, Fig. 1, of the tooth equals 0.75 of the dedendum. It will be seen that this gives a tooth shape with enough clearance to allow the tooth to enter the chain freely and without friction, the chain not coming in contact with the tooth until the block is resting on the root circle. The thickness T in Fig. 2 is made 0.9 of the inside width of the chain, indicated by S. The thickness t of the point of the tooth equals 0.6 T.

Effect of Sprocket and Chain Errors and Stretch of Chain

It will be noticed from Fig. 1 that all the meshing teeth of the sprocket are in contact with the chain, and the load would, therefore, be evenly distributed among them. While this is a theoretically correct sprocket and is an ideal condition, we are confronted with the fact that the sprocket itself is a rough casting and liable to more or less inaccuracy, due to rapping, shrinkage, etc., and the chain will vary more or less in pitch and dedendum, although the manufacturers take every possible care to keep it uniform and as accurate as it is possible to make cast chain. We also have the stretch of the chain to contend with, which begins as soon as the chain is put into use and continues until it is entirely worn out. This stretch in No. 44 or No. 52 chain may be as much as 1/4 inch in 1 foot without noticeably decreasing the strength; in fact, most users rather prefer a chain after it has stretched.

Diagram A, Fig. 3, indicates what occurs when a sprocket designed as in Fig. 1 is used as a *driver* and the chain stretches. It is easily seen that in this case the pitch of the chain has become greater than the chordal pitch of the sprocket, and it has become necessary for the chain to assume a larger pitch circle, and, as a consequence, the chain does not rest on the root circle, throwing all the wear on the faces of the teeth. In practice, this causes excessive wear on both the chain and the sprocket, and imparts a jerky, uneven motion to the drive. It is evident, then, that we must find some way of taking care of this stretch.

Root Diameter of Driving Sprocket

Different manufacturers have long recognized that a driving sprocket operates with less friction when the root diameter is somewhat enlarged. That this is true is proved by the *driver* illustrated by diagram B in Fig. 3. It will be noticed that the load is all taken by one tooth at d, which is the releasing tooth of the sprocket, and that the next tooth back of d is not in contact with the chain; also that the space between the block of the chain and the tooth increases around to point e, or the entering tooth, which enters the chain freely and just comes into contact with the block immediately behind it. This causes the chain to creep, or, in other words, to come into contact with the pulling tooth of the sprocket gradually. It also gives the chain the opportunity to stretch and still not be longer in pitch than the chordal pitch of the sprocket, and allows it to ride on the root circle, even after it has stretched considerably. Some writers claim, and no doubt they are correct, that making the *driver* over size will give a jerky motion to the chain, caused by the releasing tooth carrying the load, and, as it releases, letting the chain slip back onto the next tooth, which then carries the load until it releases, repeating this slip or jerk as each tooth releases the chain. After examining hundreds of sprockets made by dif-

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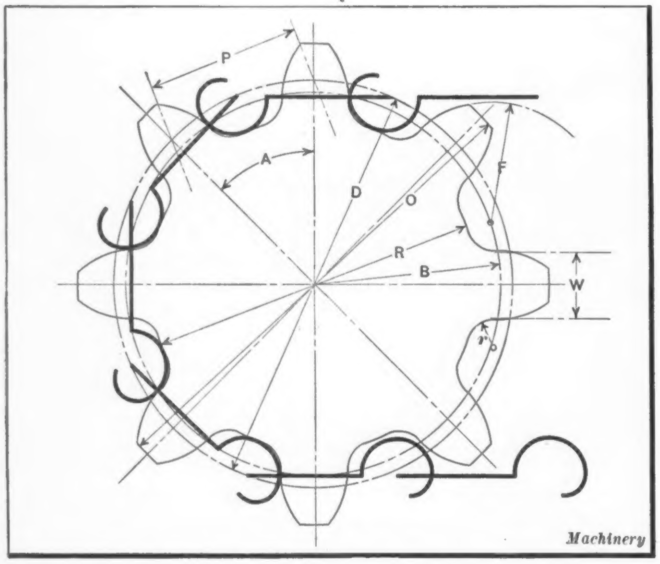

Fig. 1. Design of Sprocket which is Theoretically Correct

ferent manufacturers, and all of the data and information available, the writer has come to the conclusion that a large part of this jerk has been due in the past to the shape of the tooth itself, as in most cases, especially in the older sprockets, the sides of the tooth were straight lines, and even where curved faces were used the clearance was not sufficient to let the tooth leave the chain without friction. The shape of the

Chordal Pitch of Sprocket

A tooth width W of 0.8 L (see Figs. 1 and 2) will give, in most cases, a tooth that is wider than necessary, considering the strength of the chain, and in order to have more room for stretch, width W has been reduced so that it is more in proportion to the strength of the chain. Then in order to increase the root diameter of the sprocket and at the same time have some definite formula by which to calculate this root diameter, the chordal pitch of the sprocket has been made longer than the pitch of a new chain. This increase in the chordal pitch is governed by the width of the tooth, the dedendum of the chain, the number of teeth in the sprocket, and by the allowance necessary for inaccuracy in the chain and the sprocket. The following formula will give this increased chordal pitch. In this formula, N equals the number of teeth in the sprocket, the quantity X equals the extra allowance for clearance, and the other notation is indicated in Figs. 1 and 2.

$$P = p + \frac{p - (2d + W + X)}{N}$$

Table 1 gives the values for X which have been found most practical for the sizes of chain indicated. A practical way of finding the value of X for any size chain is to make a full-size lay-out of one tooth for a sprocket of about twenty teeth, using the formula as given in connection with Fig. 1; then, using the dedendum as a radius and the pitch line as a center, draw an arc of a circle tangent to the face of the tooth as indicated at A in Fig. 4. It will be noticed that this arc, which represents the block of the chain, does not come into contact with

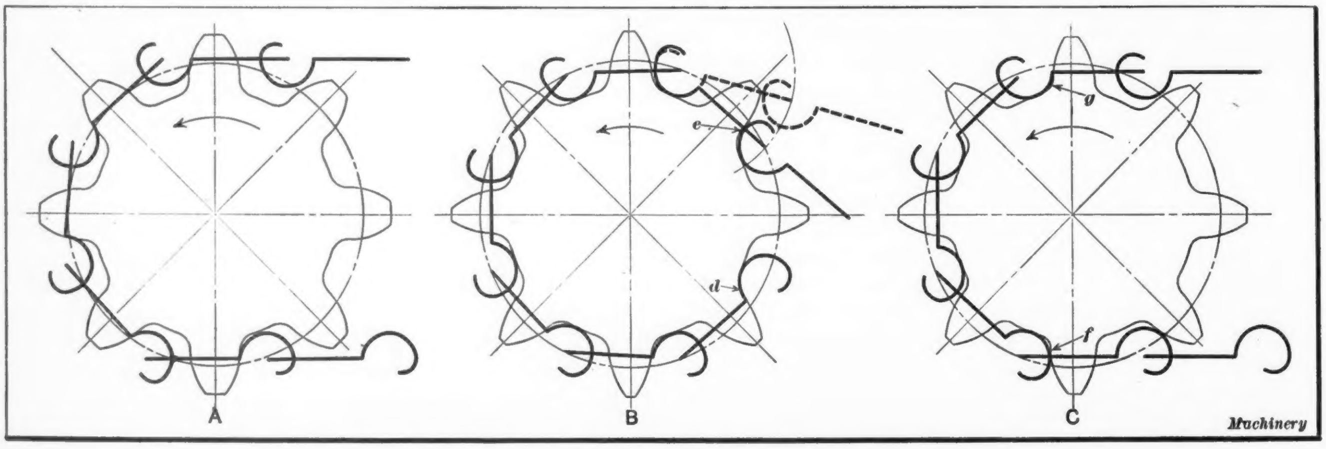

Fig. 3. Diagrams showing Position of Chain Relative to Sprocket under Different Conditions

tooth may provide clearance, which, while not entirely eliminating jerk in a new chain, will cause the action of the chain in sliding back over the face of the tooth to be so gradual that the small amount of jerk will be more desirable than using the smaller sprocket upon which a stretched chain will have to climb the sides of the teeth in order to accommodate itself to a larger pitch circle.

The sprocket shown at B in Fig. 3 is, then, considered more practical as a *driver* than the sprocket proportioned as explained in connection with Fig. 1. If a sprocket could be designed for each individual place in which it is to be used, and the designer could know the number of teeth actually in contact with the chain, he could design a sprocket which would work perfectly and take up all the stretch that the chain would be likely to develop; however, in most cases, a sprocket must be used in several different places, and it becomes necessary to design a *driver* that will accommodate itself to any condition. For this reason, the *driver* should be so designed that the chain will wrap entirely around the sprocket with the block of the last link just coming into contact with the tooth immediately in front of it, as is indicated at e in the diagram B, Fig. 3.

It is also necessary to take into consideration inaccuracy in building the pattern and in the foundry, and in this connection it is well to remember that too much care cannot be taken with the pattern and foundry work, as a very small difference in the root diameter of the sprocket will make a big difference in the operation of the drive.

the tooth on the pitch line, but will strike the tooth somewhat below the pitch line, which is equivalent to increasing the width of the tooth. This increase in width may be found by measuring the lay-out from the face of the tooth to the block of the chain on the pitch circle as indicated, and multiplying by 2. It is necessary to add 1/16 inch to this result for clearance to find the value of X. Then, using this new value for P, we can calculate the other dimensions as they were calculated for Fig. 1.

Width and Length of Sprocket Teeth

Table 2 gives the value of W for a few sizes of chain which will be found to give good results. It will be noticed from this table that the value of W decreases as the size of the sprocket

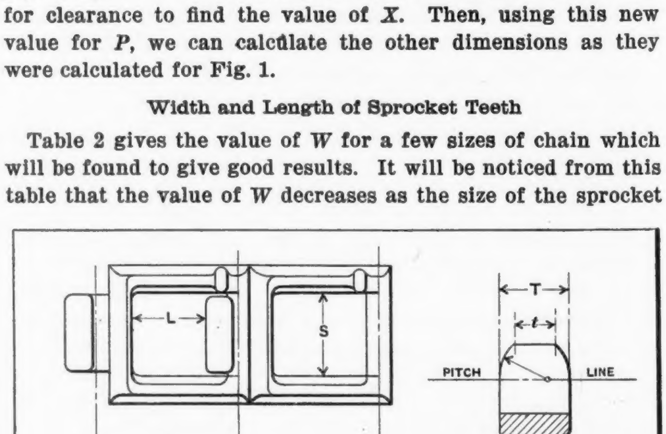

Fig. 2. Links of Malleable Chain and Sprocket Tooth

TABLE 1. VALUES REPRESENTING EXTRA CLEARANCE ALLOWANCE

Chain No.	52	62	072	075	78	88	103	115	117
Value of X, Inches	0.125	0.125	0.125	0.125	0.1563	0.1563	0.2188	0.25	0.25

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increases. This is necessary because the formula for calculating the outside diameter gives a longer tooth than will be found in other sprockets, and in order to give the face of the tooth the necessary clearance on the smaller sprockets, the value of W must be greater or the tooth will either develop to a sharp point at the top or be entirely cut off below the outside diameter. In order to get the best results in casting, it is better that the tooth should have a flat of at least 1/8 inch across the top. The values as given will accomplish this result.

The average user of sprockets, when confronted with trouble, is very likely to blame it on the length or the width of the tooth. For instance, if the chain seems to grip a sprocket and does not release readily, the average user of sprockets immediately comes to the conclusion that the teeth are either too wide or too long, when, as a matter of fact, if the tooth has the proper clearance, the length and the width have absolutely nothing to do with the fit of the chain. The root diameter governs this absolutely. If a sprocket is too large, the chain will grip on releasing, owing to the fact that it has become wedged to the sprocket from the force applied in the drive, or, in other words, the teeth are farther apart than the blocks of the chain, and prevent the chain from riding on the root circle, and as the teeth taper, they merely wedge them-

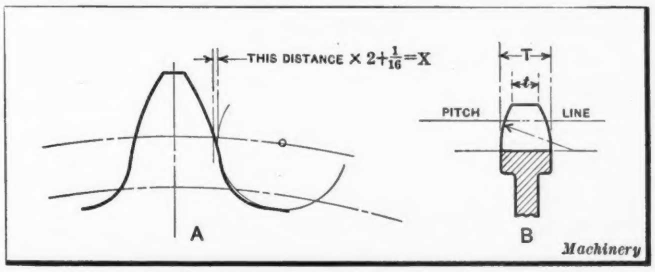

Fig. 4. Method of determining Extra Clearance Values—Modified Form of Tooth

selves into the chain and, of course, it requires quite a jerk to release them. A little grinding or filing on the root diameter of the sprocket between the teeth will always remedy this trouble. However, for stationary use, where the sprocket or the machine is not subject to side sway or slap and where the chain is equipped with good tighteners, no reason is apparent why the teeth should not be made shorter than the ones produced by the formula previously given; that is, if the sprockets were originally designed as *drivers* and *drivens*, and so used, but if it is desired to design a combination sprocket, or one that can be used as either a *driver* or *driven*, it is essential that the teeth shall be at least as long as produced by the formula. If a shorter tooth is used on a combination sprocket, the chain, in climbing, is likely to become caught on the top of the tooth and will either break the chain or the sprocket or perhaps spring a shaft. The long tooth gives ample room for the chain to climb, which it will inevitably do on this kind of sprocket. A shorter tooth, of course, will require some modification in shape, but there is an advantage to be gained in the fact that it can be made narrower in the dimension W and still not be too sharp at the top. Sketch B, Fig. 4, illustrates the modification necessary. Dimensions T and t will be the same as for the long tooth, but the taper, instead of starting at the pitch line, should start on the root line as indicated. The outside diameter should be made equal to $D + 2a$ (see Figs. 1 and 2).

Stretched Chain Applied to Driven Sprocket of Normal Size

In considering the case of the driven sprocket, it will be found by referring to diagram C, Fig. 3, that using a stretched chain on a normal sprocket will give the same results that we have just achieved in enlarging the *driver*. In other words, the pulling tooth f is the releasing tooth which releases the chain gradually, thus allowing the succeeding tooth to assume the load as in the *driver*. It will also be noticed that the other teeth of the *driven* are not in contact with the chain and that the entering tooth g enters the chain freely and without friction, just coming into contact with the block of the chain behind it. Of course, when the chain is new, all of the teeth of the *driven* will be in contact with the chain as in Fig. 1, and the load will be evenly distributed among them, but this condition will last only a few minutes after the chain is put into operation, and as the chain stretches it gradually assumes the conditions indicated at C in Fig. 3. Some authorities suggest making the *driven* smaller than normal in root diameter in order to obtain this result, but since we need all the space it is possible to get for stretch, it is evidently better policy to make the root diameter as large as possible.

Formulas for Driving and Driven Sprockets

The following formulas cover all the calculations required for a driving and a driven sprocket (for notation, see Figs. 1 and 2):

$$P = p + \frac{p - (2d + W + X)}{N} \text{ for } driver$$

$$P = p \text{ for } driven \qquad D = \frac{P}{\sin \frac{360 \text{ deg.}}{2N}} \qquad R = D - 2d$$

$$O = D + 2d \qquad B = 0.47D \qquad F = 0.17D \text{ (Minimum } F = p - d)$$

$$r = 0.75d \qquad T = 0.9S \qquad t = 0.6T$$

W should be proportional to tensile strength of chain (see Table 2). Maximum width not greater than $0.8L$.

For face sprockets:

$$R = D - 2a \qquad O = D + 2d \qquad r = 0.75a$$

Design of Combination Driving and Driven Sprocket

In some cases it is necessary to use sprockets from the same pattern as both *driver* and *driven*, and while it is not advisable, it is possible to accomplish this and still obtain fair results. We have just proved that a *driver* works better when the chordal pitch is equal to or longer than the pitch of the chain, and that a *driven* gives better results when the chordal pitch is equal to or less than the pitch of the chain. By referring again to Fig. 1 it will be seen that a normal sprocket will work equally well as a *driver* or a *driven* when the chain is new, but when the chain begins to stretch, the

TABLE 2. TOOTH WIDTHS OR VALUES W FOR DIFFERENT CHAINS AND SPROCKETS

Chain Number	Number of Teeth	Value of W, Inch
52	5–7	1/2
	8–18	15/32
	19–29	7/16
	30–50	13/32
	51–60	Min. 3/8
62 072	5	5/8
	6	19/32
	7–8	9/16
	9–17	17/32
	18–35	1/2
	36–50	15/32
	51–60	Min. 7/16
075	5	25/32
	6	3/4
	7	23/32
	8	11/16
	9–16	21/32
	17–22	5/8
	23–36	19/32
	37–60	9/16
	.....	Min. 1/2

Chain Number	Number of Teeth	Value of W, Inch
88	5–60	Min. 11/16
103	5	31/32
	6	29/32
	7	27/32
	8	13/16
	9–14	25/32
	15–60	Min. 3/4
115 117	5	1 1/8
	6	1 1/16
	7	1
	8–9	31/32
	10–15	15/16
	16–20	29/32
	20–60	Min. 7/8
	.....	....
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conditions on the *driver* rapidly become very bad and the *driven* continues to function properly. It is evident, then, that in order to design a sprocket which will serve equally well as a *driver* or a *driven*, it is necessary to effect some sort of a compromise between the formulas previously given for these two classes of sprockets.

In the formula for the *driver* we have taken advantage of all the clearance there is between the back of the tooth and the block of the chain, thus providing all the room possible for the chain to stretch before interfering with the entering tooth. In most cases, when a chain has stretched sufficiently to take up all this clearance, it has become so worn that it is of no further value. Now if we use only half of this clearance in calculating the chordal pitch, we have a sprocket that fulfills the conditions as indicated in the *driver* shown by diagram *B*, Fig. 3, until the chain stretches sufficiently to interfere with the entering tooth, or for approximately half the

TABLE 3. DIMENSIONS OF MALLEABLE CHAIN

Chain No.	Manufacturer's Dimensions			Actual Measurements from Chain		
	Pitch	Addendum	Dedendum	Pitch	Addendum	Dedendum
52	1.506	0.192	0.338	1.509	0.204	0.359
62	1.654	0.245	0.400	1.655	0.255	0.416
072	1.654	0.254	0.399	1.654	0.265	0.416
075	2.073	0.295	0.508	2.087	0.309	0.531
78	2.609	0.295	0.425	2.609	0.309	0.445
88	2.609	0.328	0.433	2.602	0.340	0.449
103	3.075	0.352	0.597	3.072	0.391	0.663
115	3.250	0.498	0.784	3.247	0.522	0.821
117	3.250	0.473	0.784	3.237	0.480	0.796

Machinery

life of the chain, while the sprocket acting as the driven member will be working at a disadvantage, owing to the fact that it is too large for a *driven* and takes the load on the entering tooth.

This causes the entering tooth to come into contact with the chain on the point and allows the chain to slide from the top of the tooth to the root circle with the full load applied. This condition will last on the *driven* until the chain has stretched sufficiently to make the pitch equal to that of the chordal pitch of the sprocket. When this stage is reached, then both *driver* and *driven* will function properly for a brief period, and no excessive wear will occur on either; then as the chain continues to stretch, the *driven* will still function properly and the *driver* will assume the wear which up to this time has been taken by the *driven*, owing to the fact that the pitch of the chain is gradually becoming longer than the chordal pitch of the sprocket and the entering tooth of the *driver* will necessarily assume the load and (as in the case of the *driven* during the first period of the life of the chain) will allow the chain to come into contact with the point of the entering tooth and slide along the face until it reaches the root circle.

The result of using a sprocket of this kind as both a *driver* and a *driven* is that during the first period covering possibly half the life of the chain, the *driver* will function properly without excessive wear, and the *driven* will be subject to all of the wear, while during the succeeding period, or say during the latter half of the life of the chain, the *driver* assumes this wear and the *driven* will function properly; in other words, this sprocket merely tends to equalize the wear.

The following formula gives the chordal pitch for a sprocket which will work equally well as a *driver* or a *driven*, but it should be understood that the results will not be as good as when the sprocket is designed for exclusive use either as a *driver* or *driven:*

$$P = p + \frac{p - (2d + W + X)}{2N}$$

Some General Points which Should be Considered

There is no question but that the lack of definite formulas for designing sprockets has been the cause of practically all of the trouble which is experienced in the use of malleable chain. Indications seem to point to the fact that the manufacturers of sprockets have left the design to the ideas of the draftsman or the patternmaker, and as there is a lack of definite data on the subject, different designs have resulted. This is evident from the fact that the same manufacturer will frequently have several different sizes of sprockets with differently shaped teeth for the same sizes of chain and the same number of teeth. The variation in diameter is very great in some cases, and in one particular case which has come to the attention of the writer, 11-tooth sprockets for No. 62 chain, made by the same manufacturer and used on the same machine, have varied as much as 1/2 inch.

In using the formulas presented in this article, it will be found that quite a few of the results are constant for the same size of chain, and that where there are a number of sprockets to be designed from time to time, it is a great convenience to construct tables of these constants, as it does away with a great deal of unnecessary figuring. For instance, the root radius r, the thickness T and t, and the value of $p - (2d + W + X)$, which is part of the formula for finding the chordal pitch, will be found to be constant for each size of chain. Another table which would be a great time-saver in the engineering department would be one showing the value of the sine of 1/2 the angle A, which, of course, will be constant for all sprockets having the same number of teeth.

It is not feasible to rely upon the dimensions of malleable chain as given by the manufacturer, and it is advisable to measure the chain. It will be found that measurements vary greatly with different shipments, and it is well to select the chains to be measured from as many shipments as possible.

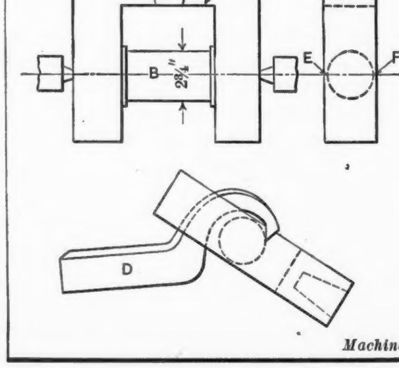
Table 3 gives the addendum, dedendum, and pitch of a few sizes of chain as given by the manufacturer and the actual measurements. These measurements have been used in designing sprockets and they are reliable.

In presenting the ideas and formulas contained in this article, no claim of new discoveries is made, but the object has been to reduce the inaccuracies and haphazard methods of the past to a reliable working basis from which it will be possible to construct standard sprockets in the same manner that we now design gears and other machine details.

* * *

TURNING CROSS-HEAD WRIST-PIN

In repairing an old steam engine it was found that the wrist-pin of the cross-head was worn on two sides to such an extent that the bearing could not be properly adjusted. It was, therefore, necessary to turn down the wrist-pin *B*. An ordinary turning tool could not be used for this purpose because of the interference of part *A*. To overcome this difficulty, the tool *D* was made. The surface of the pin from *E* to *F* was turned with this tool by rocking the work through half a circle. The rocking motion was accomplished by pulling the lathe belt back and forth by hand. The work was then reversed in the lathe and the other half of the pin turned in the same manner. E. M. P.



Cross-head and Special Tool for turning Wrist-pin

* * *

The Norwegian machine industry is developing along entirely different lines from those prevailing before the war. Whereas then most of the larger works made a number of different lines of machinery, they are now beginning to specialize on one class or type.

THE War Department has authorized the publication of the information given in the following, relating to the hand and rifle grenades used by the United States Army. Orders have already been placed for more than sixty million of these grenades, the manufacture of which will require the employment of over eighteen thousand people. Hand grenades are now produced at the rate of two million a month, but the Ordnance Department states that within the next four months this rate will be doubled. Rifle grenades are produced at the rate of about one million a month, but this rate will also be appreciably increased within the next few months.

Types of Hand Grenades

The hand grenade may be of the defensive, the offensive, or the chemical type. Of the latter there are two classes—the phosphorus and the gas type. The defensive grenade is the most powerful and is thrown from cover at an advancing foe. It is of about the same size and shape as a very large lemon. Its body or shell is made of gray cast iron and is scored with deep grooves longitudinally and transversely to insure proper fragmentation when the shell explodes.

In addition to the body, the main parts of a hand grenade are the bouchon, the detonator, and the explosive mixture. The bouchon is a die-casting composed of a tube and a projecting head. The tube is screwed into the end of the grenade body and holds the standard fuse and detonator, which are inserted into the lower (inside) end so as to bring the primed end of the fuse flush with the upper end of the tube. The projecting head consists of a cylindrical seat with four small lugs on the inside, which hold the priming cap in place over the primed end of the fuse, and a casing that contains the firing spring and the striker. These last are hinged on a pin inserted through two holes cast in the sides of the casing and are so placed that the spring, when released, will drive the striker against the primer.

The spring and striker are kept cocked by an operating lever, which hooks over the side of the casing opposite that through which the hinge-pin is inserted. This lever caps the casing and extends down along the outside of the grenade body. It is held in place by a safety pin with a ring attached to it, which passes through the sides of the casing. The small opening underneath the operating lever is closed by a sheet-metal sealer. The grenade is safe until the operating lever is released. Even after the safety pin is removed, the grenade cannot function as long as the lever is held against the body of the grenade by the hand of the thrower. In other words, the firing spring cannot operate until the grenade is thrown. The normal time for the burning of the fuse (that is, the time which elapses between the throwing of the grenade and its explosion) is five seconds.

When a soldier is ready to throw the grenade, he grasps it firmly in his right hand, removes the safety pin that holds the lever against the grenade body, assumes a position similar to an athlete putting the shot, and throws at the objective with a straight-arm, overhand throw. When the grenade leaves the hand, the lever flies up, and the striker spring is released, driving the striker against the primer, which ignites the fuse. At the end of the five-second period, the grenade explodes, providing some 300 fragments, effective at from 60 to 70 feet.

The offensive grenade differs from the defensive in that it depends entirely on its explosive effect for its usefulness against the enemy and is generally used at a shorter range, in offensive tactics, and when the grenadier is not necessarily under cover. The body is composed of a cylinder of waterproofed cartridge paper, with a conical die-cast top, threaded to receive a bouchon and operating lever, precisely like those of the defensive grenade. The fuse and detonator and method of operation are exactly similar to the other type.

Phosphorus and Gas Grenades

The phosphorus grenade has a barrel-shaped container of drawn sheet steel, about 3½ inches long and 2¼ inches in diameter; to one end of this body is welded a steel collar or bushing, threaded on the inside. Into this collar is screwed a steel thimble which runs down into the center of the inside of the body of the grenade; this thimble is designed to prevent the phosphorus charge from coming into contact with the detonator and fuse. The detonator and fuse, together with the standard bouchon assembly, of which they form a part, are screwed into the top of the thimble, which is threaded on the inside for this purpose. The grenade is painted gray when loaded, or alive. The phosphorus grenade furnishes a shower of burning fragments of phosphorus, as well as a cloud of dense white smoke, which can be used to repel an advancing attack, or, during an advance, will furnish a screen to conceal the advance and will repel any enemy parties that might be in the open.

The gas grenade is similar in construction to the phosphorus grenade, save for two annular corrugations about a quarter of an inch apart on the body, near the bottom, to serve as a dis-

tinguishing mark. It produces a low-lying cloud of dense white gas of an intensely irritating nature, which may be classed as suffocating gas. It is used largely in what might be termed "mopping-up" the trench, cleaning out dug-outs by forcing the enemy into the open, or forcing him to wear a gas mask during the advance.

Rifle Grenades

Rifle grenades are used to fill in the gap between the hand grenade and the light trench mortar. The type used was designed by two Frenchmen, Vivens and Bessieres, and in their honor is called the V. B. rifle grenade. It is about 2½ inches long and 2 inches in diameter, and is fired from the discharger, which fits over and is attached to the muzzle of the rifle in the same manner as a bayonet. The body of the grenade is a cylindrical iron casting with a rounded top and a flat base. It is perfectly smooth on the outside and fits closely into the discharger, but has deep grooves on the inside to insure proper fragmentation. It is pierced longitudinally by a central tube, through which the bullet from the rifle cartridge passes.

The firing mechanism comprises a brass fuse container and a detonator tube, the former fitting into the end of the latter. These are inserted into holes precisely opposite one another in the top and base of the grenade body, and so placed that the axis of both runs parallel to and about half an inch distant from that of the central tube. The head of the fuse container projects beyond the rounded top of the grenade body, and its inner face is fitted with a primer beyond which a striker projects obliquely over the end of the central bullet tube. When the bullet from the rifle cartridge has passed through the central tube, it hits this striker and fires the primer; from the primer, the flash is transmitted to the fuse, which runs longitudinally through the center of the fuse container into the interior of the grenade, and is timed to burn eight seconds. The fuse, in turn, fires the detonator, which bursts the walls of the detonator tube and fires the main charge, thus exploding the body of the grenade. The grenade is thrown from the discharger by the gases behind the bullet from the rifle cartridge, which, except as they follow the bullet through the central tube, exert their pressure on the flat base of the grenade. The normal range, when the rifle is aimed at 45 degrees, is about 200 yards.

* * *

FIGURING KEYWAYS ON SHAFTS

BY JOHN HAVEKOST[1]

By means of the following formulas, the depth and other dimensions of keyways can be easily found. Some other methods give values that, having been determined, make the work of finding the depth comparatively simple; but with the formulas here given the depth can be found at once. These formulas have been used with satisfactory results by the International Motor Co., of New York City, and by the Duplex Engine Governor Co., of Brooklyn. The first formula is for a flat or feather key on a straight shaft and depth of keyway in hub as shown in Case 1.

Let D = diameter of shaft;
W = width of key;
T = thickness of key;
B = diameter of shaft less depth of keyway;
$C = B + T$.

$$B = \sqrt{\frac{(D-W)(D+W)}{4}} + \frac{D-T}{2} \qquad (1)$$

Example—In the case of a shaft 6 inches in diameter, what is the depth of the keyway if the key is 1.5 inch wide and 0.875 inch thick? As $D = 6$, $W = 1.5$, and $T = 0.875$, by substituting these values in the formula we get as the diameter of the shaft less the depth of the keyway:

$$B = \sqrt{\frac{(6-1.5)(6+1.5)}{4}} + \frac{6-0.875}{2} = 5.466$$

Subtracting this from the diameter of the shaft gives the depth of keyway $6 - 5.466 = 0.534$ inch, or ½ inch very nearly.

[1]Address: 1000 E. 173rd St., New York City.

The second formula is for a flat or feather key on a taper shaft, as shown in Case 2.

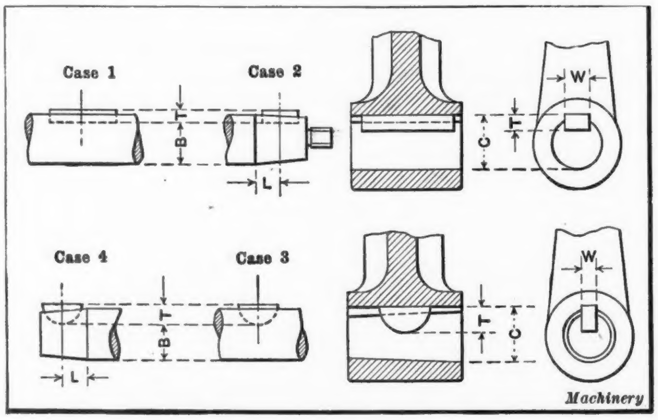
Let D = diameter of shaft at large end;
d = diameter of shaft at center line of key;
t = taper per foot;
L = distance from large end of taper to center line of key;
W = width of key;
T = thickness of key;

$$d = D - \frac{tL}{12}.$$

$$B = \sqrt{\frac{(d-W)\ (d+W)}{4}} + \frac{D-T}{2} \qquad (2)$$

Example—In the case of a shaft 6 inches in diameter at the large end, that has a taper of 0.5 inch per foot, where the distance from the large end of the taper to the center line of the key is 4 inches, what is the depth of the keyway, if the key is 1.5 inch wide and 0.875 inch thick? First of all it is necessary to find the diameter of the shaft at the center line of the key so as to substitute this value in Formula (2). As $d = D - \frac{tL}{12}$, this value is $6 - \frac{0.5 \times 4}{12} = 6 - 0.1666 = 5.833$ inches. Then $B = \sqrt{\frac{(5.833-1.5)\ (5.833+1.5)}{4}} + \frac{6-0.875}{2} = 5.3805$.

Subtracting the value of B from the diameter of the shaft at the large end of the keyway gives as the depth $6 - 5.380 = 0.620$ inch, or ⅝ inch very nearly. The remaining formulas are for keyways similar to the Woodruff key. The first is for straight shafts, and the values are the same as in Formula (1).



Notation used in Keyway Formulas

$$B = \sqrt{\frac{(D-W)\ (D+W)}{4}} + \frac{W+D}{2} - T \qquad (3)$$

The last is for taper shafts; the values in this case are the same as in Formula (2).

$$B = \sqrt{\frac{(d-W)\ (d+W)}{4}} + \frac{W+D}{2} - T \qquad (4)$$

In all cases the allowance for fit for B is ± 0.001; for C $+0.005$ to $+0.007$; and for W -0.002 to -0.004.

* * *

There seems to be some confusion as to the meaning of the terms "wrought pipe" and "wrought-iron pipe." At one time they were practically synonymous, for originally all pipe was made of wrought iron, but the use of steel pipe has increased so rapidly that now 90 per cent of the wrought pipe made in this country is of that material. According to the National Tube Co., "wrought pipe" is a term that is applied to both steel and iron pipe, and a man who advertises that he is a dealer in wrought pipe means that he sells pipe made of both materials. The term "wrought-iron pipe" means that the pipe is made of wrought iron, which is the product of the puddling furnace; while "steel pipe" is applied to pipe made of steel.

LETTERS ON PRACTICAL SUBJECTS

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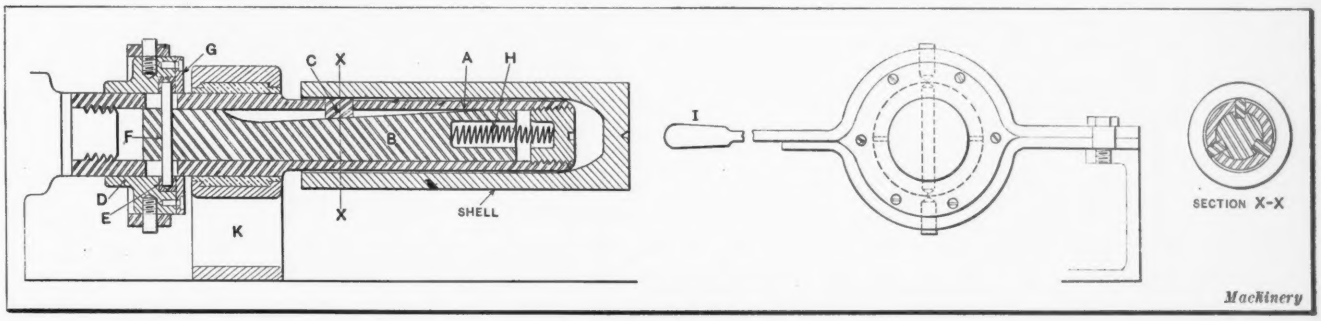
SPRING WITH DECREASING TENSION

Sometimes it is desirable to have a spring with a pulling power that decreases with the movement, such as in the case of a differential relay of the swinging pendulum type. It is necessary to operate this relay from very slight current changes and yet make a good substantial contact when the pendulum is drawn to either side of the center neutral position; besides, as it is to be used on board a ship, where there is considerable vibration, it is necessary to employ considerable spring force at the neutral point to prevent swinging. Experiments with mechanical springs showed that any mechanical spring strong enough to hold the pendulum at the center interfered with the pressure of contact at the platinum points, and sometimes the pendulum failed to make contact at all, as the pull at the contact position was stronger than at the center.

The problem was solved by using a magnetic spring, for the pull of magnetism decreases as the square of the distance, which exactly suits the given conditions. A special magnet was made by cutting a sheet of 1/8-inch tool steel to the form desired, approximating that of a horseshoe magnet; the pole pieces have V-points, which are separated by 1/4 inch. It was then attached to the base in such a position that the pendulum can swing between the pole pieces without touching them. A small iron wire, pointed at each end, passes through the pendulum at this point, and is short enough to afford a liberal clearance when passing between the poles. When operating, the magnet draws the iron wire, and hence the pendulum, to the exact center and holds it there with all the force desired. Its strength is easily adjusted by changing the length or diameter of the wire, and its operation is perfect.

Jersey City, N. J. HARRY E. DEY



Centering Spindle for Shells

DRILLING A LARGE JIG

Frequently the men in charge of small shops in country towns have to devise methods of doing work with equipment that was not intended for the purpose. One such problem was the drilling of holes in the jig shown in Fig. 1.

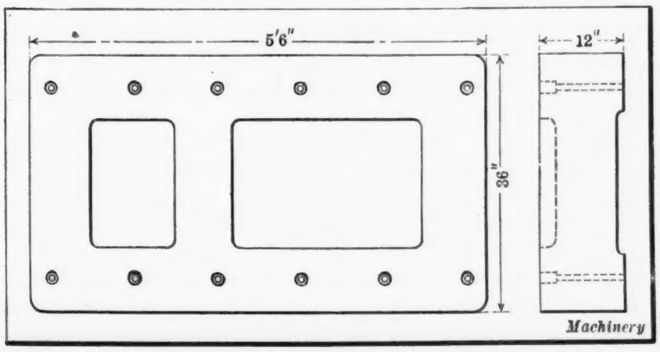


Fig. 1. Jig in which Holes were to be drilled

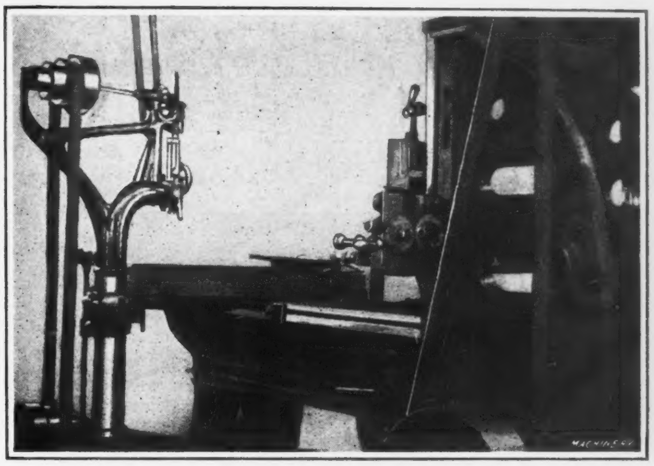


Fig. 2. Supporting Jig on Planer while it is being drilled

This casting was of the dimensions shown and weighed 750 pounds; it was therefore too large to be placed on the only available drilling machine. The holes were 1 inch in diameter and 1½ inch deep and were reamed and spot-faced to receive hardened plugs, which were then forced into them. In order that the plugs could be removed in case of breakage, ½-inch holes were drilled through the casting from the bottom of the holes. As the casting was too large to be supported by the bed of the drilling machine, the press was placed beside a planer, as shown in Fig. 2, and the casting was supported by the planer. Of course, care had to be taken to get the press in line with the planer; but when this was done satisfactory results were obtained.

Milwaukee, Wis. FRED FRUHNER

CENTERING SPINDLE FOR SHELL WORK

The centering spindle shown in the accompanying illustration has been used with success in centering 4.5-inch high-explosive shells. After the shells are bored, the base end is cut off and the shell is recentered on a small engine lathe fitted with the special spindle as shown. A flat center drill is used in the tailstock, which is so arranged that it may be rapidly withdrawn when putting the shell on or taking it off the spindle. A steadyrest is provided as shown at *K*. The shell is pushed onto the spindle until the bottom of the shell comes in contact with the end of the spindle. The open end of the shell is then centered by three hardened steel dogs *C* which are operated by spindle *B*. This spindle has three taper slots in which the dogs are fitted and is forced back by compression spring *H* which causes the dogs to expand and grip the walls of the shell. The shell is released by operating the hand-lever *I* which causes the sliding sleeve *D* to move forward. This sleeve has a split ring *E* which

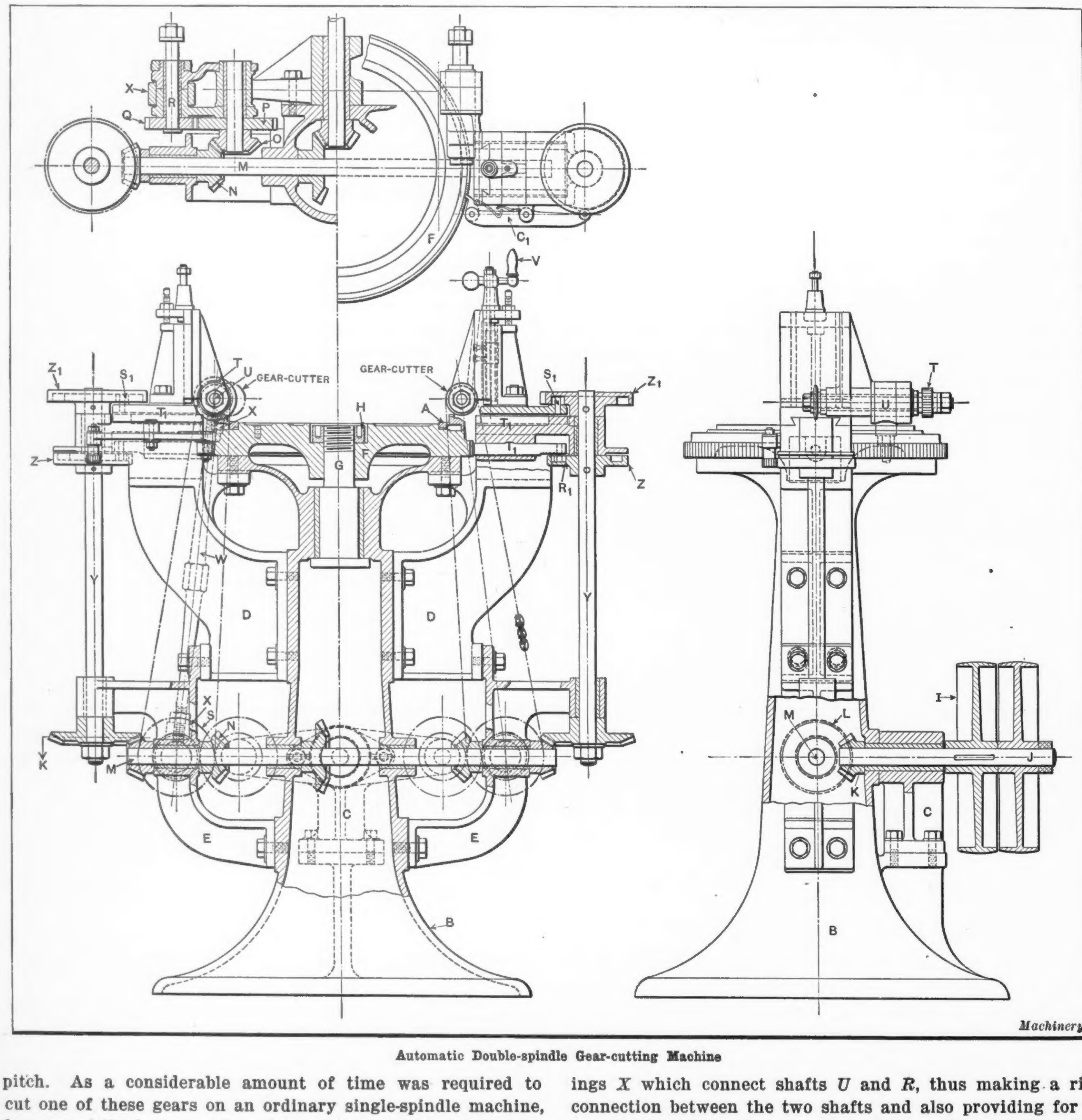
is held in place by part *G*. The pin *F* which is in ring *E* causes the spindle *B* to move forward, thus releasing the grip of dogs *C*. Pin *F* also serves to drive the split ring *E* when the lathe is in motion.

Alberta, Canada J. HOMEWOOD

AUTOMATIC DOUBLE-SPINDLE GEAR-CUTTING MACHINE

The machine shown in the accompanying illustration was designed and built to cut crown gears used on a certain type of knitting machine which is used to knit stockings and other wearing apparel. The crown gears, which at the present time are required in large quantities, have 360 teeth of 24 pitch. As a considerable amount of time was required to cut one of these gears on an ordinary single-spindle machine, because of the large number of teeth, the machine shown was designed and built with two spindles, which carry milling cutters for automatically cutting teeth on opposite sides of the gear blank simultaneously. In the lower left-hand view is shown a vertical section of the machine, while directly above this view is shown a half-plan and half-section through the driving mechanism. At the right is shown a side elevation. As the teeth are small, the sides of the teeth in the gear are cut straight instead of radial. This, however, does not interfere with the proper working of the finished product.

The machine consists of a stand *B* to which brackets *C* and *D* and arm brackets *E* are bolted. The work *A*, in which the teeth are to be cut, is securely fastened to the revolving plate *F*. The latter rests upon stand *B* and turns about fulcrum *G*. Fulcrum *G* turns in a bronze bearing and is held in place by nut *H*. A loose pulley turns on shaft *J*, thus allowing the driving belt to be shifted from pulley *I* which is keyed to shaft *J* when it is desired to stop the machine. The shaft *J* transmits its motion to bevel gear *K*, and the latter drives bevel gear *L* which is keyed to shaft *M*. The two gears *N* and *O* drive the spur gears *P* and *Q*. The latter is keyed to shaft *R* which carries the sprocket *S*. A Whitney silent chain transmits motion to the sprocket *T*. The sprocket *T* as well as the milling cutter are keyed to the shaft *U*. This shaft is supported in a bearing which may be raised or lowered by turning the handle *V*. The turnbuckle *W* is threaded in castings *X* which connect shafts *U* and *R*, thus making a rigid connection between the two shafts and also providing for adjustment. Gear *Q* will roll upon gear *P* when the gear-cutter is raised or lowered.



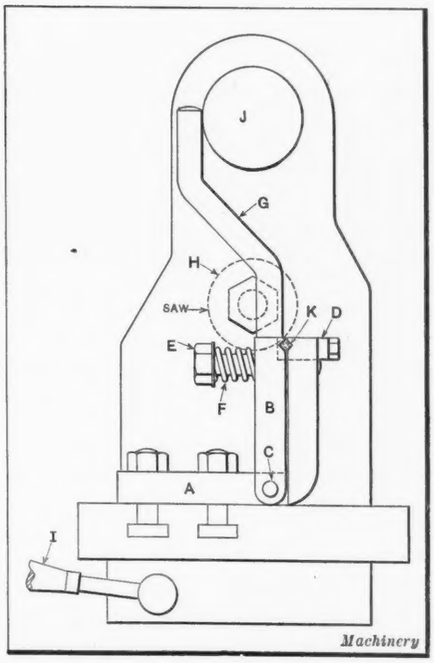
Automatic Double-spindle Gear-cutting Machine

The motion of shaft *M* is transmitted to the vertical shaft *Y* by bevel gears. Cams *Z* and Z_1 are fastened to shaft *Y*. Cam *Z* and roller R_1 move the stop-bar T_1, which either releases or arrests revolving plate *F*. The lever C_1 is also operated by this cam and is fitted with a pawl which turns the plate *F* at the same moment that it releases the stop-bar T_1; the stop-bar T_1 automatically drops into place when the plate *F* turns into the proper position for cutting the succeeding tooth. While this movement is taking place, the gear-cutters are returning to their former positions and are ready to repeat

the operation. The slow forward movement of the cutters during the cutting process and the quick return is controlled by cam Z_1 and roller S_1. The roller S_1 is attached to the slide T_1, which moves horizontally. Bolted to this slide is a carriage guide in which the carriage with the bearing for the shaft *U* moves vertically. All bearings are lined with bronze bushings and are provided with a proper lubricating system.

St. Louis, Mo. L. EISENKRAMER

MILLING MACHINE FIXTURE FOR SAWING OFF TUBES



Milling Machine Fixture for sawing off Tubes

The fixture shown in the accompanying illustration was designed for use in sawing up a large quantity of 3/16-inch soft steel tubes into lengths of about four inches. This fixture was used on a hand milling machine with excellent results. It consists of two main parts *A* and *B*, hinged on a pin *C*. At the top of these pieces is cut a V-shaped groove, as shown at *K*, through which to slide the tubing. At *D* is shown a piece of steel fastened to part *A* and bent at one end to form a stop, against which the tube strikes when it is slid endwise through groove *K*. At *E* is shown a bolt which is screwed into *A*, passing through a clearance hole in *B* and carrying the tension spring *F*, which holds *A* and *B* tightly together. At *G* is a pin which is driven into the top of part *B*. The position of the saw in relation to the fixture is shown by the dotted lines *H*.

The fixture is bolted to the table of the milling machine in such a position that when the hand-lever *I*, which operates the table feed, is pulled up, the table travels forward until pin *G* strikes on the over-arm *J*, and so, overcoming the tension of spring *F*, allows a tube to be pushed into the groove between *A* and *B;* then, as the handle is pressed down, the spring again comes into action and closes *B* tightly on the tube. As the table travels still farther back, the tube is brought into contact with the saw and is sawed off. This motion can be accomplished so rapidly that from 15,000 to 20,000 pieces can be cut off in ten hours. It is necessary to run the saw at an extremely high rate of speed; otherwise the teeth will soon be broken out.

New York City DONALD A. BAKER

POLISHING TWISTER AND SPINNING RINGS

Twister and spinning machine rings made from forged steel are turned on automatic machines. They vary in size and section according to the size and kind of yarn that is being spun or twisted, some of the larger sizes, as shown in Fig. 1, being four or five inches in diameter. The finished rings require a high polish, both inside and outside. The outside polishing is performed on a speed lathe, sticks of No. 90 emery being used. The inside polish was formerly produced in a similar manner, but the amount of time consumed was so great that a better and quicker method was finally adopted.

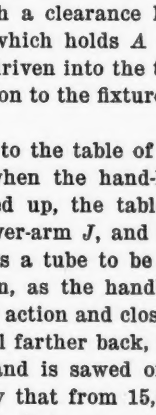


Fig. 1. Ring for Spinning Machines

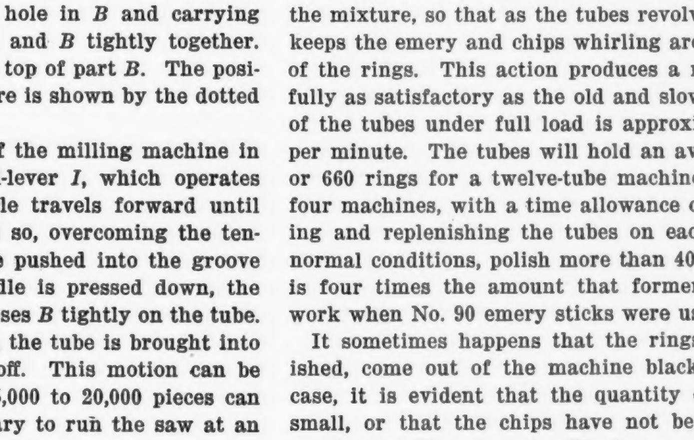


Fig. 2. Special Machine designed for polishing Inside of Twister and Spinning Rings

A special machine was built for this purpose, one end of which is shown in Fig. 2. The gear end contains a set of gears, arranged as shown, there being a driver of 45 teeth, six intermediate gears of 38 teeth, and twelve gears of 21 teeth each, the latter being mounted on short spindles, driving twelve tubes of iron pipe. These tubes *A*, of course, vary in diameter according to the size of the rings to be polished, and are easily removed from their bearings to be emptied or filled. A screw cap clamps the rings *C* securely in the tube after a mixture of emery and annealed cast-iron chips has been poured in. The success of the polish depends upon two things, namely, the proportion of emery and chips, and the length of time that the rings are run in the machine. The proper percentage of emery and chips can only be determined by experimenting, but an approximate formula is from one to two parts of emery to five parts of iron chips. Nos. 36 and 46 emery are used, according to the size of the ring, and large chips from 3/8 to 1/2 inch long produce the best results. The time allowance is a more definite factor, usually being about two and one-half or three hours.

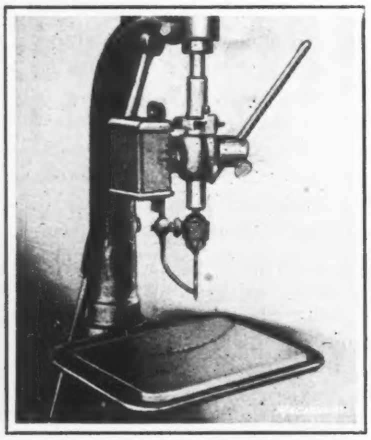
The chamber formed by the walls *B*, of the rings, Fig. 1, as they are clamped in the tubes, is only about half filled with the mixture, so that as the tubes revolve, the centrifugal force keeps the emery and chips whirling around on the inside wall of the rings. This action produces a mirror polish, which is fully as satisfactory as the old and slower method. The speed of the tubes under full load is approximately 750 revolutions per minute. The tubes will hold an average of 55 rings each, or 660 rings for a twelve-tube machine. One man, operating four machines, with a time allowance of two hours for emptying and replenishing the tubes on each machine, can, under normal conditions, polish more than 4000 rings per day. This is four times the amount that formerly constituted a day's work when No. 90 emery sticks were used.

It sometimes happens that the rings, instead of being polished, come out of the machine black and dull. In such a case, it is evident that the quantity of emery has been too small, or that the chips have not been large enough. The varying quality of steel will also sometimes account for this result. Leather chips have been tried with the emery in place of the iron chips, but with unsatisfactory results.

F. R. DANIELS

LUBRICATING SMALL DRILLS

In the accompanying illustration is shown a simple device for lubricating small drills, which has been found very satisfactory for work that requires some lubrication but not very much. It consists of a half-pound cocoa can, to which is soldered a strip of steel in which the clamping screw holes are tapped, while a piece of 1/8-inch copper tubing, to which a stop-cock is soldered, is attached to the bottom. The can is then clamped to the sensitive drilling machine on which it is to be used. It can be made in a little over an hour, and provides a good lubricating system for a type of machine that



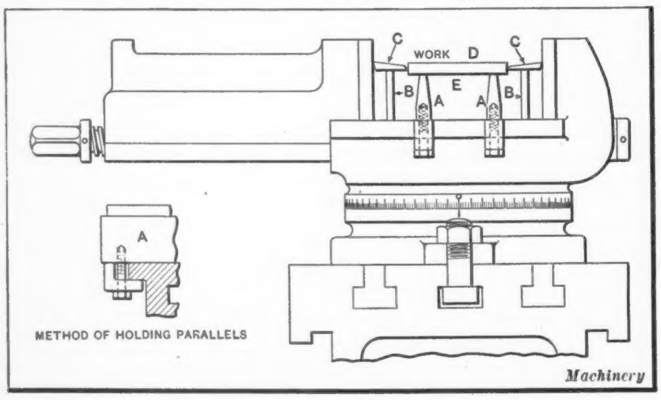
Easy Method of lubricating Small Drills

rarely has any. The copper tube is bent so that the end rests against the drill, thus carrying the oil or compound right to the tool without spilling any. For the drills used —up to 3/32 inch—only a few drops a minute are required. The chips are not sufficient to cause any serious stoppage of the oil, and while the work is being changed the oil finds its way down and is ready at the point of the drill when the hole is started. The small size of the tube and its flexibility make a system that is economical and neat, and the can holds from two to three days' supply of oil. The advantages of this device are its economy of oil and time. As a rule, a squirt can is used for work of this kind and the operator wastes most of the lubricant; besides, time is required to fill the cans and everything is covered with oil. If the lubricant is applied with a brush, the results are nearly as bad. The time taken to handle any extra part is a dead loss.

Middletown, N. Y. DONALD A. HAMPSON

METHOD OF HOLDING WORK ON A SHAPER

A method of holding work on a shaper that saves considerable time when shaping or planing two surfaces parallel is shown in the accompanying illustration. By the use of this method the machinist may be certain that when the work is completed the two surfaces *D* and *E* will be parallel. Anyone who has had experience on shaper work has, no doubt, experienced difficulty in clamping work in the vise so that these surfaces may be planed parallel. After taking a cut across the work, it is often found that the piece is thicker at some points than at others. It is then necessary to place



Method of holding Work on Shaper

some thin paper under the corners or sides that are found to be thickest, after which a trial cut is taken over the piece, and this operation is repeated until the surfaces of the work are found to be parallel and finished to the required size.

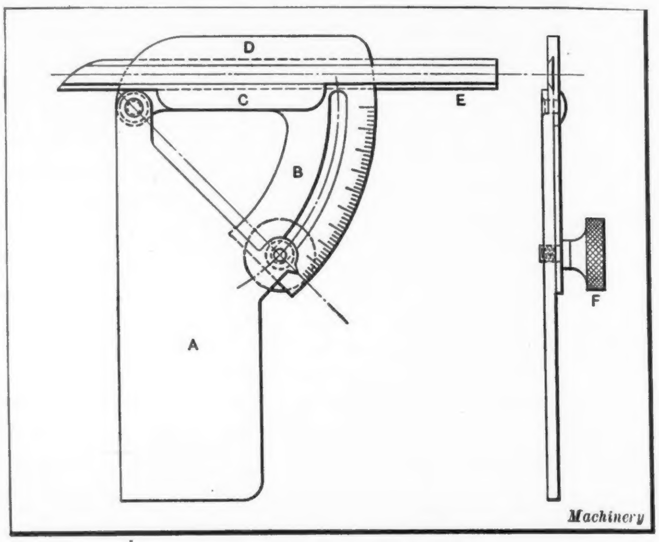
The writer has found the following method to be a very simple and accurate way of handling this class of work. The first step in setting up a piece of work is to clamp a pair of parallels *A* to the vise as shown in the illustration. These parallels should be placed near the edge of the work, but before placing the work upon them, a very light cut should be taken over their top surfaces. The next step is to place the work in the vise upon the parallels *A*. The hold-down clamps *C* are then placed on the parallels *B* which should be a little higher than *A*. By tightening the vise, the action of the hold-down clamps will grip the work securely on parallels *A*.

In the writer's opinion this method is much more satisfactory than the old method of shimming up the work. The depth of cut taken over the parallels *A* should not be greater than that necessary to true them up, as otherwise their life will be materially shortened.

Muskegon, Mich. A. E. PEARSON

ANGLE GAGE WITH SLIDING BEAM

An angle gage fitted with a sliding beam, which was designed for use in die-sinking, is shown in the accompanying illustration. The sliding beam serves not only as an angle gage but as a depth gage as well. It is used when different depths of the same angle are required in the impression, and is particularly useful in gaging impressions where circular ends and curves have the same angle but different depths that vary from the maximum depth to zero. The parts *A* and *B* are made from sheet steel and the sliding beam *E* is made from an annealed hacksaw blade. The pieces *D* and *C* that



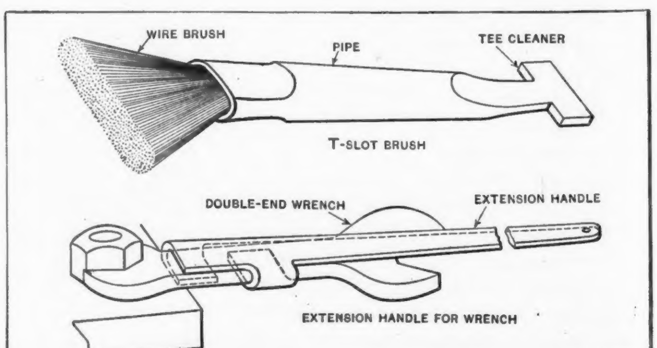
Angle Gage with Sliding Beam

form the dovetail groove in which beam *E* slides are also made from annealed hacksaw blades and are riveted to *B*. The sliding beam *E* is fitted in the dovetail groove so that it can be easily adjusted, yet it is fitted tight enough to prevent it from moving out of adjustment when in use. The gage can be set at the required angle and held in place by tightening the knurled nut *F*. The beveled edges of the sliding beam serve as a knife-edge in gaging.

Ilion, N. Y. C. W. SHELLY

T-SLOT BRUSH AND EXTENSION FOR DOUBLE-END WRENCH

In the accompanying illustration are shown two useful tools that can be easily made by any machinist from scrap material. The T-slot brush shown at the top of the illustration will be found useful for cleaning out the slots of the planer, miller and drilling machine platens or tables. It is made from a piece of ¾-inch pipe, and some ⅜-inch wire cable, the brush being made by first flattening the end of the pipe and inserting two short pieces of the wire cable. These are soldered to the



T-slot Brush and Extension for Double-end Wrench

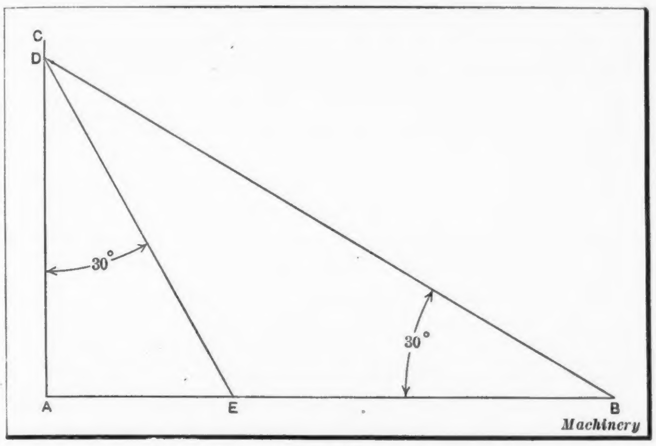
flattened portion of the pipe, and the strands then teased out to make the brush. The other end of the pipe is split on one side and opened out flat, then cut to a T-shape to fit the slots.

An extension for a double-end or S wrench is shown in the lower view. The usual method of extending a single-end wrench is to slip a piece of pipe over the end. This method, however, cannot be employed on a double-end wrench. The extension shown was designed for use on double-end wrenches, but it can also be used on single-end wrenches. It can be made from flat stock and will be found very convenient wherever double-end or S-wrenches are used.

Concord, N. H. C. H. WILLEY

DIVIDING A LINE INTO THREE PARTS

Some time ago the writer found a quick and exact method for dividing a line into three parts, which he has not seen in any handbook. Let AB in the accompanying illustration be



Method for dividing a Line into Three Parts

the line to be divided. Draw AC perpendicular to AB, and from B draw a line forming a 30-degree angle with AB and intersecting AC at D; through D draw a line forming a 30-degree angle with AD, intersecting AB in E. AE is then one-third of AB. The proof of this is: $AD = AB \tan 30$ degrees $= \frac{AB}{\sqrt{3}}$. $AE = \frac{AD}{\sqrt{3}} = \frac{\frac{AB}{\sqrt{3}}}{\sqrt{3}} = \frac{AB}{3}$.

Brooklyn, N. Y. KURT MANRODT

STOP-GAGES FOR PRESS WORK

The writer has found that considerable loss in shearing or shearing and punching die products is due to defective stop-gages. This loss has been overcome in one shop, however, by the use of the stop shown in Fig. 1. This stop is designed to be clamped to all gage bars. This is set at the proper position for specified lengths by means of a taper pin A which passes through the stop and gage bar. The key B eliminates the danger of marring the gage bar with the cup point of the set-screw, which would in some cases make it impossible to change the stop 1/32 inch one way or the other without the set-screw slipping from a previously cupped setting.

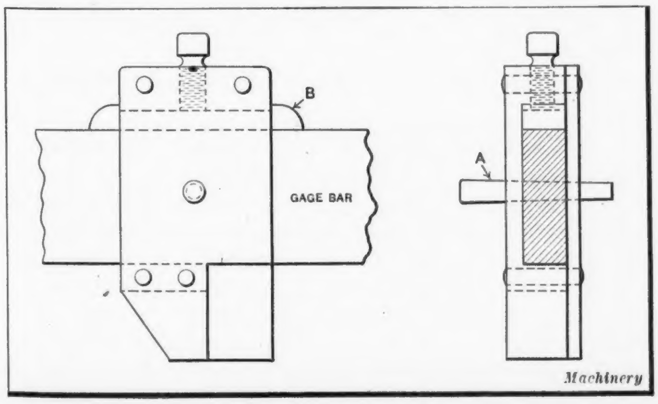


Fig. 1. Stop for Gage Bar

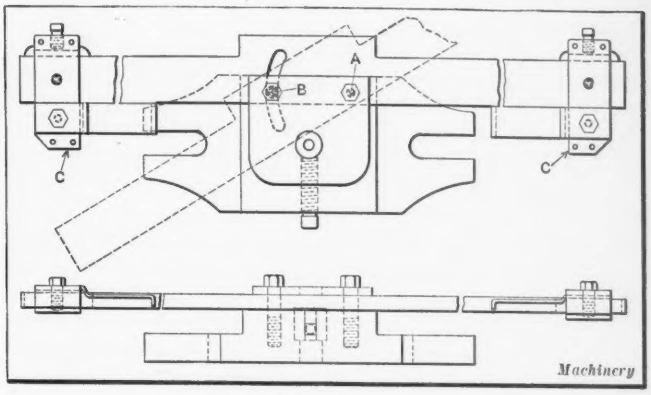


Fig. 2. Adjustable Gage Bar

Punch work requirements often call for holes of varying sizes and different locations in respect to the ends of the piece as well as the sides. It is also necessary to make provision for different widths of material. To meet these requirements, the gage bar shown in Fig. 2 was designed, constructed, and put into successful operation. It will be noticed that the back of the gage bar is pivoted at A under one corner of the stripper plate, and the opposite end of the plate has a cap-screw B working in a slot in the gage bar. This permits it to be located at any distance from the edge of the material and for any width. The universal stops C on each end of the gage bar furnish two gage points, so that sliding a piece either to the right or to the left will establish positive punch locations for two holes at one handling of the same piece. The die with which this gage bar is used is made with round die inserts in the shoe and has a capacity for punching holes from 1/8 to 1/2 inch. The punches, of course, are changed in the punch-holder to conform with the die insert in the shoe.

Cedar Falls, Iowa G. M. PIPER

MANUFACTURE OF BRASS STUFFING TUBES

In the manufacture of brass stuffing tubes some interesting problems were met. The walls of the piece were very thin, as shown in Fig. 3, so it was decided to finish the outside first,

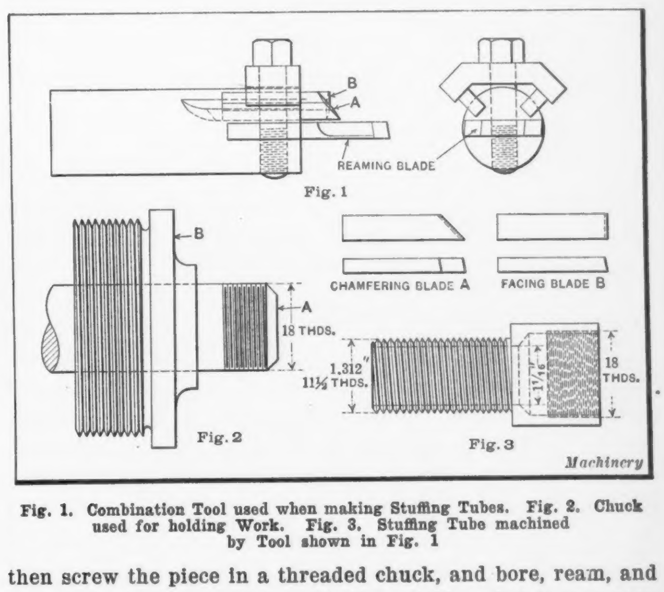


Fig. 1. Combination Tool used when making Stuffing Tubes. Fig. 2. Chuck used for holding Work. Fig. 3. Stuffing Tube machined by Tool shown in Fig. 1

then screw the piece in a threaded chuck, and bore, ream, and thread the hole concentric with the outside. But it was soon discovered that the work could not be done in this way for the following reasons: First, the thread on the work would not be of the same lead as that in the chuck, as anyone who has threaded a long piece with chasers will have discovered; this, of course, prevented screwing the work into the chuck the full length of the thread when the diameter was apparently all right. Second, the boring-bar was so long that it would not stand up to the work, but would spring away, letting the tool ride on the scale of the casting; the chuck was so constructed that it was impossible to support the boring-bar at both ends. Third, the reamer, when a little dull, would expand the work

instead of cutting, so that the ring gage would not go on after finishing the hole.

It was then decided to finish the large end of the hole first, using for this purpose the combination boring, facing, and chamfering tool shown in Fig. 1; the hole is then threaded. In the next operation, the work is gripped by this finished portion in the chuck shown in Fig. 2; this chuck consists of a threaded arbor *A*, which is attached to the draw-bar on the turret lathe and slides in faceplate *B*. After the work is screwed on the arbor and drawn back against the faceplate, a box-tool is used to finish the outside, facing the shoulder and end in one operation. The first die is now run on and the piece rough-threaded; then the hole is finished from the rough with a four-fluted reamer held rigidly in the turret, after which the finishing die is run on. The work requires no boring, as the hole is cored within 3/32 inch of size. This method results in a first-class job and the tooling equipment is simpler and easier to keep in repair. A little foresight in the planning of this job at the beginning would have resulted in a large saving of time and money.

Boston, Mass. JOHN A. SHAND

A DEPARTMENT CALL BOARD

In most manufacturing plants it is customary for a man when leaving his department for any length of time to advise someone as to where he may be found in case he is urgently needed. Where this is not done considerable confusion and delay is caused by the effort to locate the person when wanted. To eliminate this trouble, a department call board was designed and instituted in a certain plant. This system facilitates the recording of information regarding the whereabouts of the absent man. The chief functions of the call board are as follows:

1. To record the destination of each person going out of the department, and if several places are to be visited by him the order of the trip being made.

2. To automatically call to the attention of the man on his return to the department, any call, either by person or telephone, that may have been made during his absence, and to leave instructions to see or telephone to any person or department listed on the board.

3. To provide a convenient place and form for recording special notes regarding extended trips, odd locations, etc.,

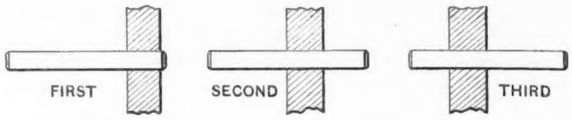
Names of Department Members

⊘ Designation	Phone No.	*W. I. Smith*	*H. B. Jones*	*L. M. Brown*	*D. C. White*	*R. S. Stone*				⊘
Superintendent	437	○	○	○	○	○	○	○	○	
Production Dept.	326	○	○	○	○	○	○	○	○	
Stock Room	245	○	○	○	○	○	○	○	○	
Cashier	621	○	○	○	○	○	○	○	○	
		○	○	○	○	○	○	○	○	
		○	○	○	○	○	○	○	○	
Not out over 15 min.	—	○	○	○	○	○	○	○	○	
Outside Plant	—	○	○	○	○	○	○	○	○	
See Pad	—	○	○	○	○	○	○	○	○	
			⊘							
Extra Plugs										

Fig. 1. Form of Call Board used in One Plant

DIRECTIONS FOR USING CALL BOARD

1. Never leave or enter the room without properly plugging or removing the plugs from this board.
2. A white plug indicates that a person is at the place designated.
   A red plug means to call the place indicated.
   A black plug means to go to the place indicated.
3. When it is necessary to make special notations, plug the "See Pad" hole and write the note on the pad.
4. When going to several places, indicate the order of stops by inserting the plug to various depths as follows:



Machinery

Fig. 2. Directions for using Call Board

whereby anyone may quickly ascertain the facts without asking questions.

Fig. 1 gives a general idea of the call board as worked out in one office. It consists of a typewritten sheet containing the names of all the members of the department and the places most frequently visited, arranged as shown. Three-sixteenth-inch holes are located which align with similar holes in the wooden board to which the sheet is pasted. At the bottom of the board a small trough is attached which contains an assortment of different-colored 3/16-inch plugs about 1½ inch long. This board can be easily made by a carpenter in a short time. A convenient spacing for the holes was found to be ⅝ inch. The board was then located near the telephone and a notice similar to the one shown in Fig. 2, placed above it. In installing this system the board should be located in a central position, preferably near the exit and telephone.

Fort Wayne, Ind. G. G. STEVENSON

SPECIAL TABLES PREPARED FROM TABLES IN MACHINERY'S HANDBOOK

Some time ago, while employed as assistant foreman in a hand and automatic screw machine department, the writer had occasion to refer to MACHINERY'S HANDBOOK quite regularly for information pertaining to the special work being done in this department. As this information was required by nearly all the men employed in the department at one time or another, the writer prepared a special table containing all the necessary information in a convenient form. This table, which was copied from sections of different tables contained in MACHINERY'S HANDBOOK, was then sent to the drafting-room, where a tracing was made. Blueprints were then made from this tracing and given to the men, who glued them to the inside of their tool-chest covers. After being glued in place, the blueprints were given a coat of shellac to keep them from becoming oil soaked. The use of these tables resulted in a great saving of time, as it was no longer necessary for the men to wait for the writer to look up the desired information in the HANDBOOK.

Aurora, Ill. J. J. BORKENHAGEN

PREMIUM FOR NO SPOILED WORK

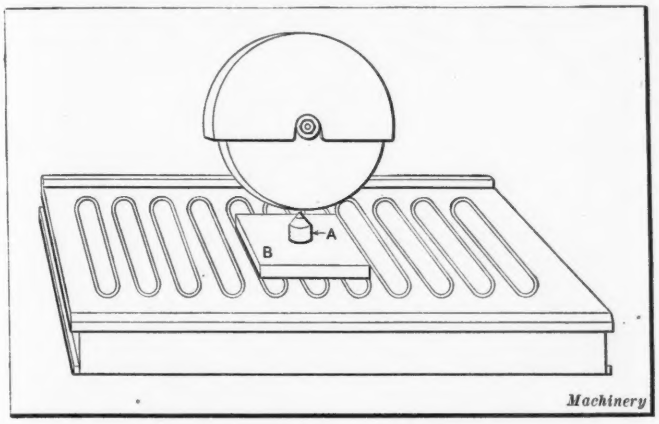
To reduce the amount of work spoiled, where work is done by day's wages, a premium may be offered each month to each worker who has had no spoiled work charged to him. This may also be advisable where piece-work is in operation, as it is to the employer's interest to have little material spoiled. The amount of premium should be gaged by the value of the material or parts and the liability to error, due to material, machinery, or methods.

New York City ROBERT GRIMSHAW

SHOP AND DRAFTING-ROOM KINKS

DIAMOND HOLDER

In the accompanying illustration is shown a simple and convenient form of diamond holder that may be used on any grinding machine that has a magnetic chuck. The diamond is mounted in the usual way in the soft iron holder *A* which is firmly fixed in the base *B*. In truing up the grinding wheel, it is only necessary to place the holder on the sur-

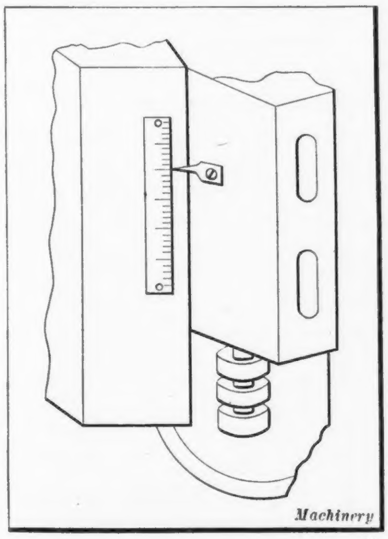


Convenient Diamond Holder

face of the magnetic chuck where it can be held in the same way as a piece of work. The diamond point can then be brought into the proper position for truing the wheel by the use of the cross and vertical feeds.

New York City — E. J. Higgins

GAGE FOR DOUBLE-ACTION PRESSES



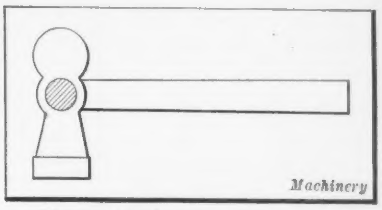
Gage attached to Double-action Press

Convenient attachments for a double-action press are a six-inch scale fixed to the left guide and an index finger fixed to the ram, as shown in the accompanying illustration. These attachments will be found especially convenient in setting up tools and in adjusting for pressure, as the amount necessary to raise the ram to allow for the thickness of stock to be accommodated can be readily determined.

George F. Kuhne
East Rutherford, N. J.

A SCHEME FOR SAVING DRILL POINTS

In some shops where the drilling machines are fitted with tapered friction tool-holders, it is the usual practice for the operator to tap the drill after it has been placed into the taper socket by striking it on the point with a hammer. This is obviously poor practice, as the point of the drill is often broken off when struck with the hard steel hammer. Instructions are frequently issued to protect the drill with a piece of wood when driving it in, but this method is usually inconvenient and hence is not followed. The hammers for use in driving in drills in the drilling machines in one establishment are fitted with pads made out of babbitt metal as shown in the accompanying illustration. A shallow hole is drilled in one side of the hammer, in which is poured babbitt, which promptly sets into place. When the operator desires to tap in a drill, he uses the same hammer he ordinarily employs, but merely turns it over to the side containing the babbitt pad, which, being considerably softer than the drill point, acts as a cushion and prevents the breakage of the point.

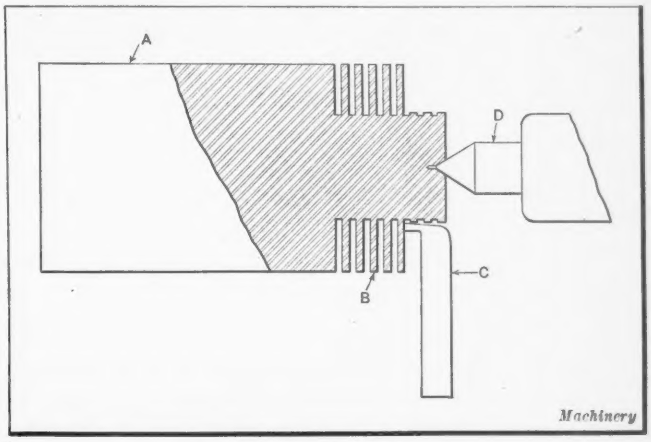


Hammer fitted with Babbitt Pad to protect Drill from Injury when driving it into Socket

Philadelphia, Pa. — W. A. Lailer

MAKING TOOL-STEEL WASHERS

A saving in time and stock may be effected by making tool-steel washers as follows: A bar of tool steel *A* is held in the lathe chuck at one end and supported by the lathe center at the other end as shown. The bar is first turned to the required outside diameter of the washers. A cutting-off tool is then



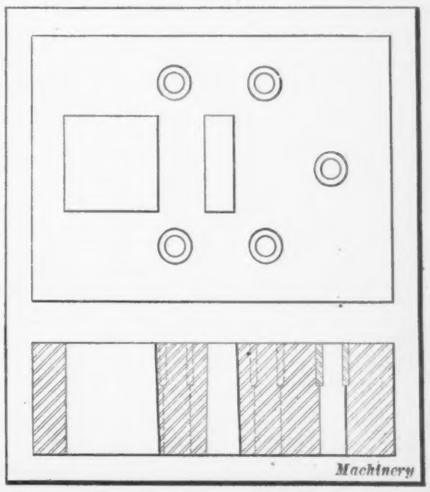
Making Tool-steel Washers

placed in the tool-holder and the bar turned down as shown at *B*, each section being the required thickness of the washers. The turning and boring tool *C* is then used to cut off the washers, the tool being set to bore the hole in the washers to the proper size. After each ring is cut off, the carriage is run back and the ring allowed to drop over the center *D*.

Ambridge, Pa. — August J. Lejeune

BUSHINGS FOR PIERCING DIE

When piercing zinc 1/8 inch thick with punches 9/64 inch in diameter, the small holes in the dies become bell-mouthed and worn long before the larger holes in the piercing section; but by using bushings in the small holes, as shown in the accompanying illustration, and replacing these when they become worn, the die is prevented from being prematurely discarded.



Use of Bushings on Piercing Die

E. J. Higgins
New York City

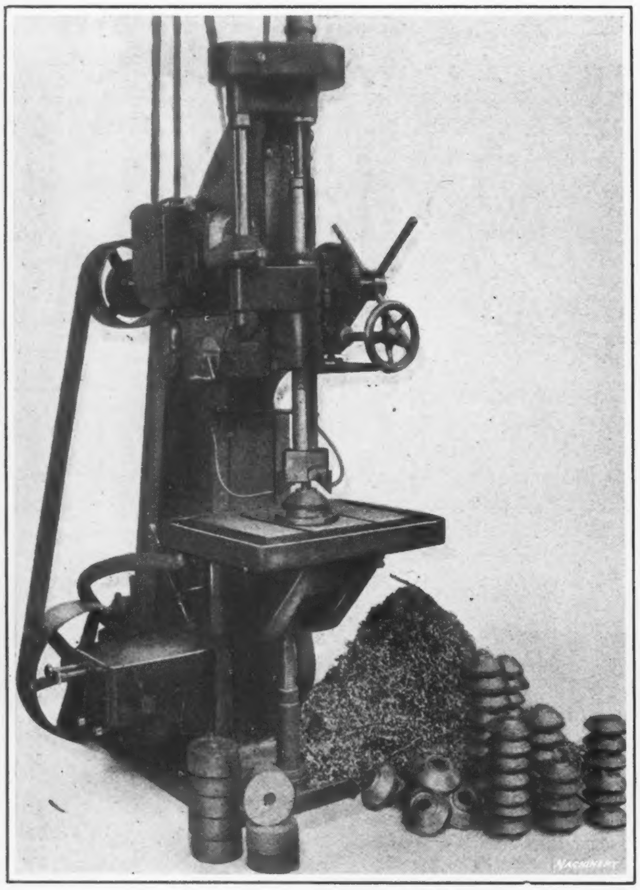


Fig. 1. Baker Bros. High-duty Drilling Machine tooled up for performing Forming Operation on Bevel Gear Blanks

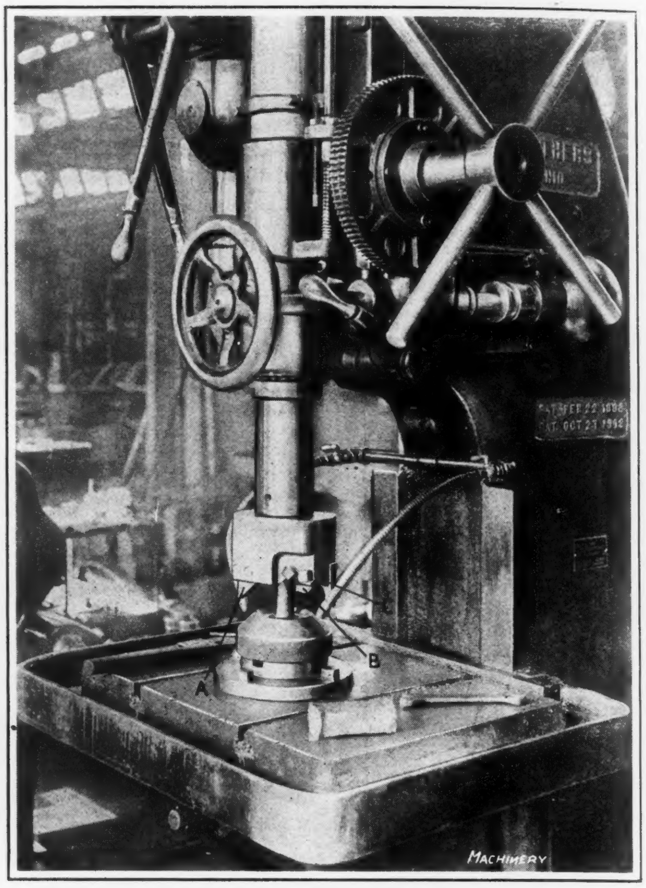


Fig. 2. Close View of Tools and Work-holding Fixture for forming Bevel Gear Blanks on Baker Bros. High-duty Drilling Machine

FORMING OPERATION ON A DRILLING MACHINE

During recent years there has been a considerable increase in the range of work handled on drilling machines, which has been made possible both through the development of more serviceable machines of this type and through a better understanding by machinists of the possibilities of the modern high-duty drilling machine. A somewhat unusual way of performing a forming operation will be seen in the accompanying illustrations, where there are shown the tools and work-holding fixtures provided for turning up bevel gear blanks from steel forgings, some of the rough forgings being shown at the left-hand side of the machine in Fig. 1, while turned gear blanks and chips appear at the right. For handling this work, the order of operations is as follows: First, drill hole through center of blank; second, cut keyseat in blank; third, locate work on piloted fixture and form one side of blank as shown in Fig. 2; fourth, turn work over and form opposite side of blank as shown in Fig. 1. In the first forming operation, as shown in Figs. 2 and 3, it will be seen that the face of the gear blank is formed by tool *A*, tool *B* cuts the recess, and tool *C* cuts away the excess metal to reduce the gear blank to the required outside diameter. After this operation has been completed on all of the gear blanks, the tools are changed and the work is turned over and set up in the fixture, as shown in Fig. 1, so that the opposite side of the blank may be turned to the desired form, which is indicated by the cross-sectional view in Fig. 3. The gear blanks are turned from steel forgings, and evidently a high-duty machine is required to handle severe service of this kind. It will be noticed that the pilot *D* on the work-holding fixture extends up into a bushing *E* in the tool to eliminate all chance of springing the tool away from the cut. The work is shown in course of production on a No. 314 high-duty drilling machine built by Baker Bros., Toledo, Ohio, and the gear blanks being turned are for the bevel gear drive on these machines. E. K. H.

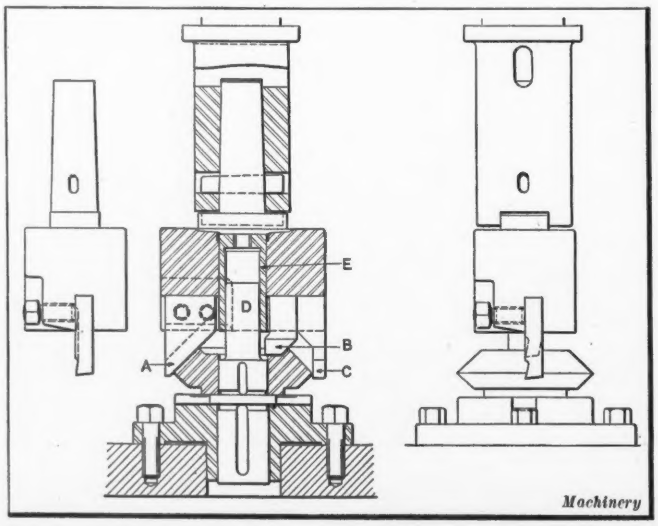


Fig. 3. Sectional View of Tool and Work-holding Fixture shown in Fig. 2

* * *

REDUCING LABOR TURNOVER

It is stated that the labor turnover in plants engaged in war work has become so great that it is in danger of affecting the volume of production of war materials, and the United States Employment Service has therefore decided to investigate the conditions in the factories with a view to reducing the turnover. It is planned to have representatives of the Employment Service and an expert in industrial management visit one of the large war plants which has had the greatest trouble in this respect, and make a study of the internal conditions of the plant in order to take steps to remove the causes that result in men leaving their work after a few days or weeks. As many as two thousand unskilled workers a week have been required in this particular plant because of the constant leaving of help. The establishment of the Employment Service has reduced the labor turnover to a large extent, but it is hoped that a still greater reduction can be made by studying the internal conditions of the plants. Besides increasing the output of war materials through steadying the supply of labor, this investigation will probably have the added advantage of bettering working conditions in general.

CONVENTION OF THE AMERICAN GEAR MANUFACTURERS' ASSOCIATION

THE semi-annual meeting of the American Gear Manufacturers' Association, held in Syracuse, N. Y., September 19 to 21, was remarkable for the spirit of cooperation which prevailed among the manufacturers, and for the definite and clearly defined aims of the association. At the present time the two most important phases of the work of the association relate to the cooperation of different manufacturers in a business way, and the efforts toward standardization of gearing, which undoubtedly will have valuable results.

Opening Address by President of Association

The meeting was opened by an address by F. W. Sinram, vice-president of the Van Dorn & Dutton Co., Cleveland, Ohio, who is the president of the association. In his address, Mr. Sinram particularly emphasized the fact that few men, not actively identified with the gear industry appreciate fully the importance of the gear manufacturers' product in the war program. Gears are required in practically every device necessary for waging war. Ships and submarines, guns, airplanes, trucks, tanks, are only a few examples of the implements of war and the accessories in the conduct of the war where gears are used to a large extent. In addition, gears are used in practically all the devices of peaceful endeavor that at this time are turned into uses supplementary to the conduct of the war, such as farm tractors, cranes, steam shovels, motors, etc.

The important items in the manufacture of gears were further emphasized. The production of gears is a technical and highly specialized business, and to conduct it efficiently a personnel of highly technical and mechanical ability is required. Many phases of gear production also demand skilled workers to an extent not required by the average metal-working industry.

Attention was then given to the two important phases of the work of the association—cooperation and standardization. Cooperation is now demanded as never before between those operating in the same field, if they are to serve the common good in the most effective way. Standardization is equally important in the interest of production and economy. The association's program for standardization of gearing is gradually taking shape, and is recognized as one of the most important questions relating to the future of the gear industry. Uniformity of business practice is also being inaugurated, and what might be called "commercial standardization" is receiving consideration, one of the questions in this direction relating to standard specifications.

Report of Committees

A number of committees presented reports. Of these, the most interesting one, from a technical and mechanical point of view, is the report of the Standardization Committee, of which B. F. Waterman, of the Brown & Sharpe Mfg. Co., Providence, R. I., is chairman. The subject of standardization has been considered for some time by the association, and a committee was appointed at a previous meeting to carry on this work. This committee, in turn, established subcommittees for different types of gearing and different phases of the gear manufacturing business. To each chairman of these subcommittees has been outlined the subjects that are considered most important in connection with the standardization work, and a brief summary of the report is given in the following:

Bevel Gearing—(1) The design of gears with an idea of producing rules and formulas whereby all gear manufacturers may produce approximately the same product. (2) Formulas for the strength of gear teeth and the relation of strength to wear. (3) The adoption of a standard long addendum for straight-tooth bevel gears, and the modification of addendum and dedendum to agree with the correct or normal pitch, as is practiced in helical spur gears. (4) A standard specification sheet for use in making contracts and placing orders.

Spur Gearing—(1) Rules and formulas for the design whereby different manufacturers may produce approximately the same product for the same purpose. (2) Formulas for the strength of spur gear teeth and for the relation of strength to wear. (3) A standard specification sheet for use in making contracts and placing orders.

Worm and Spiral Gearing—(1) Rules and formulas for the design of worm-gears to produce general uniformity of the product. (2) Formulas for the strength of worm-gears and for the relation of strength to wear. (3) A specification sheet for use in making contracts and in placing orders whereby both customer and maker will know exactly what is to be produced.

Composition Gearing—(1) Standard methods of construction as advised by manufacturers of this type of gearing. (2) Standard methods of handling the material to prevent absorption of moisture. (3) Formulas for strength of various kinds of materials used in this type of gearing. (4) Methods of cutting and the speeds and feeds permissible. (5) Tabulations of successful drives, giving full details as to life, load (both full and intermittent), speeds, etc. (6) A standard specification sheet for use in making contracts and placing orders.

Hardening and Heat-treating—(1) Depth of case and its relation to pitch and service. (2) Materials and treatments suitable for different services. (3) Standardization of scleroscope and Brinell readings.

Herringbone Gearing—(1) Formulas whereby standardization of design may be made possible. (2) Formulas for strength and for the relation of strength to wear. (3) Tabulation of successful designs, giving complete details as to load, speed, life, etc. (4) A specification sheet for use in making contracts and placing orders.

Sprockets—(1) Formulas that will produce uniform designs, including uniformity as regards hubs, arms, rims, etc. (2) The heat-treatment of small sprockets. (3) A tabulation of the strength of various kinds of chains with safe working speeds, these data to be obtained from chain manufacturers.

In conclusion, the standardization committee recommended that the things more easily standardized should be handled first and the more difficult things saved until further experience had been gained in this work.

Reports were also submitted by committees working on rules for a standard set of specifications for gearing and by the committee on commercial questions and considerations relating to the gear manufacturing industry.

Papers Read at Convention

The address of the greatest importance at the convention was that by Charles A. Otis, chief of the Resources and Conversion Section of the War Industries Board, who spoke on "The Adjustment of the Industries to War Work." A brief abstract of this paper is given on page 162.

An address entitled "What is the Possibility of Women Becoming a Permanent Factor in the Gear Industry?" was presented by W. H. Diefendorf of the New Process Gear Corporation, Syracuse, N. Y. In this address Mr. Diefendorf called attention to the fact that women are now being employed, not only on the lighter operations in machine shops, but also on heavy work such as the milling of engine bases and on certain portions of the engine assembly, the work in this case requiring the use of chain hoists and the aid and guidance of male overseers and assistants. In view of these facts, it is evident that women operators can be used on the heavier as well as on the lighter varieties of gear work, although the largest field for female help is in connection with the blanking and cutting of small gears on a piece-work basis. Women also make excellent inspectors in the gear industries, their delicate touch being more sensitive than that of a man, which aids them in detecting imperfections when giving gears rolling tests. This ability, coupled with their quick eyes and nimble fingers, gives them an advantage in gaging and visually inspecting finished parts. Mr. Diefendorf expressed the opinion that women will remain in many industries after the war in which they have not been formerly employed, and also indicated as his opinion

that women were especially suited in the gear manufacturing industry and that gear manufacturers generally ought to employ them in the present emergency.

An address on "The Outlook of the Steel Supply" was given by C. E. Stuart of the Central Steel Co., Massillon, Ohio. Attention was called to the two factors responsible for the shortage of steel. The first and most important one is coal, which limits the steel supply. As it takes approximately four tons of coal to produce one ton of steel, it is clear why the coal production is so vitally important. As an example, it was mentioned that in the defense of Verdun two million tons of steel were fired at the enemy, requiring in its manufacture nine million tons of coal. The second great factor is transportation. The transportation of coal is the greatest single item of transportation in the United States. The moving of the entire cotton crop of the United States is equivalent only to the amount of coal moved in thirty-two hours. The moving of the entire wheat crop is equivalent only to the movement of coal that takes place in eight days. The steel supply is extremely short, and it will hardly be possible to produce the amount of steel required for the absolute war necessities; hence, every non-essential business using steel must, within the near future, be eliminated, and must turn into other channels of production. Drastic action is required in this respect, and the Government must handle the situation firmly. The speaker also called attention to the method of handling foreign labor that had been inaugurated by the Central Steel Co., and their efforts toward Americanization and toward the improvement of the living conditions of their workmen.

An address on "Trade Acceptances" was read by C. E. Crofoot of the Crofoot Gear Works, Boston, Mass., in which he strongly advocated the introduction of this business auxiliary in the general commercial practice of the manufacturers in the United States.

Social Side of Convention

The convention was marked by a most unusual spirit of good fellowship, many of the members expressing themselves as surprised to see competitors meet in such a cooperative and friendly spirit. On the evening of September 19 the Brown-Lipe-Chapin Co. and the Brown-Lipe Gear Co., both of Syracuse, N. Y., gave a dinner to the association, and on the evening of September 20 an informal dinner was held by the association members themselves. A luncheon was served the same day to the members at the works of the New Process Gear Corporation, and after the luncheon the afternoon was spent in the inspection of the works of this company as well as those of the Brown-Lipe-Chapin Co.

* * *

ADJUSTMENT OF THE INDUSTRIES TO WAR WORK[1]

BY CHARLES A. OTIS

Chief of Resources and Conversion Section of the War Industries Board, Washington, D. C.

The work of the Resources and Conversion Section of the War Industries Board consists in adjusting the industries, as far as possible, to the war situation, and the section may be considered as representing the business interests of the country in their relation to the Government. The section was created some months ago under a plan approved by the War Industries Board, which divided the country into twenty regions, each region having a representative called a regional advisor. The appointment of this advisor was made upon the representation of the business organizations in the region. The object of the whole system is to make it possible for the industries to cooperate in their efforts to help win the war and in maintaining their own industrial and commercial existence inasfar as this is possible under the war conditions.

With the enormous increased program of the Army, the shortage of one of our most important materials—steel—is a factor that must be given serious consideration. From all reasonable and conservative estimates, the steel situation is such that all available steel will be consumed in the production of materials for war purposes—much of it directly and the remainder indirectly. In view of this, it is absolutely necessary that everyone immediately curtails the use of steel in every direction which does not pertain to the war program.

Enormous amounts of steel are necessary to maintain the transportation system. One-third of the total amount of steel produced is required for the railroads alone; one-eighth is required for the completion of the shipping program; and from one-sixth to one-fourth for the making of shells. Hence, considerably more than one-half the total steel-producing capacity of the nation is used in these three directions alone. With the enormous tonnages required in the building of machinery, trucks, buildings for war purposes, cantonments, docks, and for the making of guns and ordnance of all kinds, it is evident that there will be nothing whatever to spare for purposes that are not absolutely essential at the present time. All departments of the Government are making every effort to work in the closest harmony with the manufacturers in the conservation of steel, and the regional advisors and other governmental agencies in the various sections of the country can be very helpful, both to the manufacturers and to the Government, in regard to the conservation of steel.

The regional advisor brings to the attention of the Ordnance Department all the facilities for manufacturing that are reported through the business organizations with which he is in touch. The requirements of the Ordnance Department, in turn, are submitted to the Resources and Conversion Section and transmitted to the regional advisors so that, in this way, the manufacturer who can make a bid for war work may be placed in touch with the department that requires work done.

There are many cases where small manufacturing plants have felt that they should have had part of an order, but it is evident that most orders can be placed with a view to more prompt delivery with someone who is already engaged in making the product required, and it would be unwise to make an effort to develop another factory for the making of a product already obtainable from an experienced organization. This, at least, is true when speed is an important consideration. In the manufacture of articles where there is already an ample supply, there is, however, no reason why new resources should not be used, and the policy is that all of the existing resources and manufacturing plants shall be taken advantage of, as far as possible, before additions are made to existing plants.

It is evident that, under the great pressure that has developed, the larger institutions of the country have been able to handle the business more rapidly, and it was, therefore, easier and wiser to take advantage of these large organizations. Now, however, the time has come when manufacturers having smaller plants may also be called upon for direct contracts. In this connection it is important that the smaller concerns in various localities cooperate. Any manufacturer knows that it is not practicable to place an order for one hundred parts among a great many concerns, as their overhead would take away any possible profit, and the problem of inspection would be very difficult. However, if a group of manufacturers combined to turn out an article, taking the responsibility of the contract as an organization, the impracticable features might disappear. This method of combination is all the more important as in almost every small organization or machine shop there is a very practical man at the head, and in many cases the quickest developments have come through a combination of two or more smaller concerns.

It is therefore suggested as a wise move to establish a committee of practical mechanical men in every town that has enough industries to warrant such a committee, and to have this committee prepare a survey and recommend to the factories what they can do in combination. There are many instances where larger concerns have been greatly assisted by suggestions from smaller ones, and in some cases the larger firms have therefore practically absorbed the smaller organizations as a whole, still keeping them intact for after-the-war work. The larger institutions of the country are now being urged to do all they can along these lines, and it is expected that fine results will soon be noticed. It should also be mentioned that the mechanical and other engineering societies of the country have offered their services in every region for assistance and advice in this work.

[1]Abstract of a paper read before the American Gear Manufacturers' Association, at Syracuse, New York, September 20, 1918.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

The New Tool descriptions in MACHINERY are restricted to the special field the journal covers—machine tools and accessories and other machine shop equipment. The editorial policy is to describe the machine or accessory so as to give the technical reader a definite idea of the design, construction, and function of the machine, of the mechanical principles involved, and of its application.

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TRACEY TOOL-ROOM SPECIALTIES

This article describes a machine for testing the lead of lead-screws of any length or pitch, and of any diameter up to 3 inches; there are also described a thread milling attachment for use on engine lathes and a universal angle fixture. These tools will prove of interest to those engaged in handling tool-room work or in the performance of certain classes of precision manufacturing operations where these types of tools are employed.

In order to facilitate certain tool-room and manufacturing operations, the C. H. Tracey Co., 161 Summer St., Boston, Mass., is now building a machine for testing the lead of lead-screws, a thread milling attachment for lathes, and a universal angle fixture. Patents have been applied for on each of these specialties. From the following description and illustrations the reader will obtain full information concerning the features of each of these tools.

Lea Lead-screw Testing Machine

The lead-testing machine shown in Fig. 1 has been developed by Charles Lea and is being placed on the market by the Charles H. Tracey Co. It has been developed for the particular purpose of testing the lead of lead-screws of any pitch or length, and of any diameter up to 3 inches. By means of special attachments, lead-screws of any diameter may be accurately tested. Briefly, this testing machine consists of two accurately finished 3/4-inch steel bars, supported in brackets at each end and provided with a sliding carriage, having a secondary floating carriage mounted on ball bearings. By means of an accurately ground plunger which drops into the thread groove, the secondary carriage is held so that a micrometer reading can be taken. Under the end brackets that hold the two steel rods are V-blocks, and beneath these are bronze clamps that locate the lead-screw and hold it firmly up into the V-blocks.

Mounted on the inner face of the left-hand end bracket there is a stop, and on the left-hand end of the sliding carriage there is a similar stop. In testing a lead-screw, the carriage is brought toward the left so that the two stops are in contact. Then by adjusting the secondary floating carriage, the plunger is dropped into the nearest thread groove, which, of course, holds the secondary carriage against movement. Then by means of the micrometer head at the right, pressure is brought on the plunger of the dial indicator located on the secondary carriage until the dial indicator reads zero, and at this point the reading is taken to 0.0001 inch of the micrometer graduated wheel. Without changing the location of the main carriage, the secondary carriage is next moved so that the plunger may drop into the next thread groove, and the reading is similarly taken. Thus by moving the plunger from thread to thread and taking readings at each thread, the accuracy of the lead-screw can be determined.

In using this lead-testing machine in connection with distance blocks, Johansson blocks or other precision distance blocks may be used, and the reading is first taken with the stops in conjunction. Next, the blocks to make up any desired distance are placed between the stops, and a reading is taken, thus giving the accuracy of the lead over any desired length. If desired, special distance blocks will be furnished with the lead-testing machine, and those recommended are two 6-inch blocks and one 3-inch block. While the readings are being taken, the carriage is positively locked with a knurled set-screw. The bearing surfaces between the carriage and the secondary carriage are hardened and ground. With each machine a set of three plungers is supplied for testing Acme threads. Plungers for any style thread can be furnished as extra equipment.

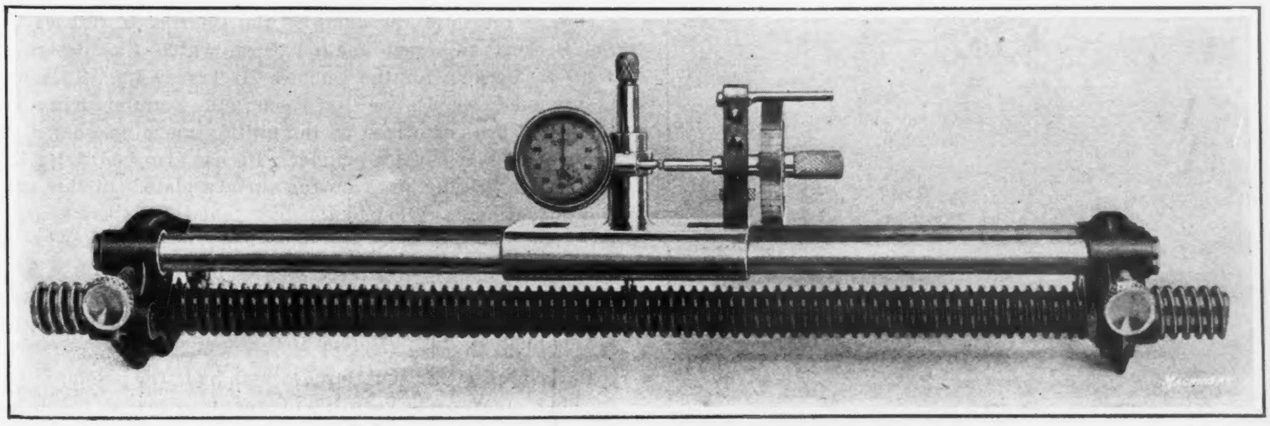


Fig. 1. Machine developed for C. H. Tracey Co. by Charles Lea for testing Lead of Lead-screws

Beckett Thread Milling Attachment

Another recent product of the Charles H. Tracey Co. is a thread milling attachment that is shown in Figs. 2 and 3. This attachment was designed by John R. Beckett and is intended for use on any lathe which is provided with a lead-screw. It is attached on the cross-slide, being located in the toolpost slot by means of a steel tongue from which there extend two studs, fitted with clamping nuts. As the thread lead is obtained from the lead-screw from which the attachment is used, it is possible to get any pitch of thread from the gearing of the lathe. This attachment is provided for taking any of the standard thread milling cutters regardless of the pitch. The thread milling cutter is motor-driven from a 1/4-horsepower motor that is a part of the attachment.

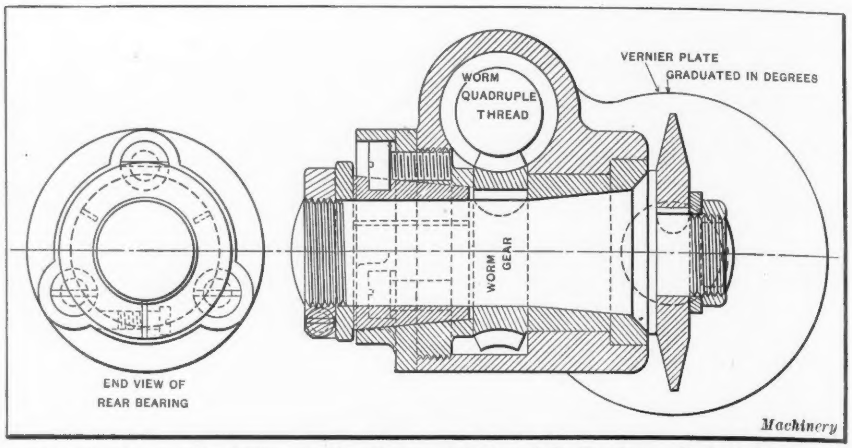


Fig. 3. Cross-sectional View showing Design of Cutter-spindle Bearing on Beckett Thread Milling Attachment

Referring to the illustrations, it will be seen that the motor shaft is furnished with a small pinion that meshes with a large gear on the auxiliary shaft that runs parallel to the motor shaft. On the opposite end of the auxiliary shaft there is a gear connection to a secondary driving shaft, and at the outer end of this secondary shaft is a hardened steel worm. This steel worm meshes with a phosphor-bronze worm-wheel that drives the cutter-spindle, which, it will be seen, is at right angle to the secondary and auxiliary shafts.

Features of the construction of the cutter-spindle and its bearings may be clearly seen in Fig. 3. The bearing is provided with a double taper, being 5 degrees at one section and 45 degrees at the outer end. Where the end thrust is taken at the opposite end of the spindle, the bearing is provided with a slanted take-up sleeve. By means of three closing-in screws, it is possible to adjust the straight bearing, and at the same time retain the alignment perfectly. The end thrust is taken care of by means of a thrust washer and split lock-nut that may be drawn tight at any point and held positively in place. A small grease cup located directly over the worm-shaft provides oiling facilities for the worm and worm-wheel as well as the cutter-shaft bearings. It will be noticed from Fig. 2 that the cutter-spindle may be swiveled any number of degrees to the right or left of the vertical plane, to provide for the cutting of any helix angle. It may, if desired, be swiveled 90 degrees so as to cut a keyway or spline in a shaft, and in each of these cases it is necessary to hold the shaft from rotation. Graduations and a vernier are provided, so that the cutter-head may be accurately set to any desired angle in degrees and minutes. The cutting point is always maintained in the same plane as the lathe centers.

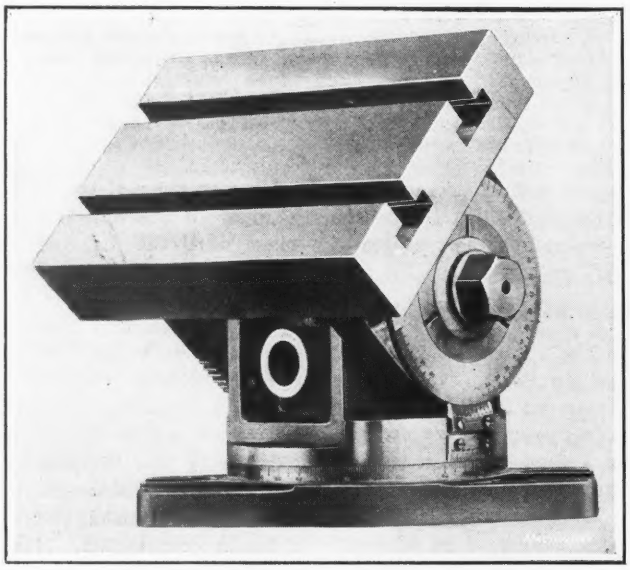


Fig. 4. Universal Angle Fixture developed for C. H. Tracey Co. by John R. Beckett

With this attachment, any lathe may be easily converted into a thread milling machine, the accuracy of the work produced depending upon that of the lead-screw of the lathe. As to capacity, any length or diameter that may be handled on the lathe can be thread-milled with this equipment. A particularly useful field for this attachment is in the threading of taps. By providing the lathe with a relieving attachment in addition to the thread milling attachment, the taps may be threaded and relieved simultaneously. In the making of thread gages, this is a particularly valuable attachment, because the thread may be milled, and after hardening, by substituting an emery wheel in place of the thread milling cutter, the thread may be ground on the same machine on which it was cut. For the grinding operation it is necessary, of course, to disconnect the gearing from the cutter-spindle and substitute a grinding wheel and a driving pulley to provide the proper grinding speed for the wheel. This attachment is also being built in a larger size for handling extremely heavy work.

Fig. 2. Thread Milling Attachment for Lathes developed for C. H. Tracey Co. by John R. Beckett

Beckett Universal Angle Fixture

One of the latest products of the Charles H. Tracey Co. is the Beckett universal angle fixture, which was designed by John R. Beckett for the Charles H. Tracey Co. This fixture is intended for use on tool-room and manufacturing operations that are performed on the milling machine, shaper, drilling machine, or surface grinder. Its use also facilitates laying out and inspecting work on the surface plate. In this connection attention is called to the fact that the fixture is particularly adapted for sine bar measuring operations. In many shops where work is blocked up, and special makeshift fixtures are used for obtaining angular settings for the work, particularly compound angular settings, this universal angle fixture will be appreciated.

In designing this tool, Mr. Beckett had two principal points in mind; one was to keep the overhang as low as possible and the other was to provide means for clamping the angle fixture so that settings would not be distorted. The fixture was also

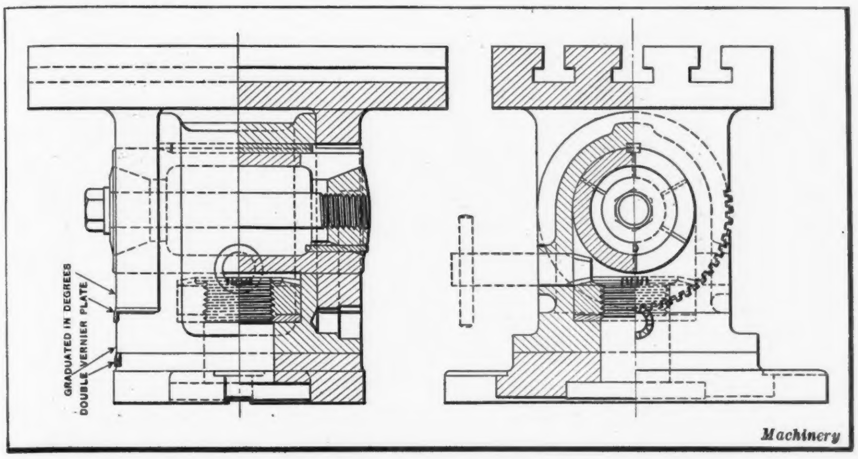


Fig. 5. Features of Design of Beckett Universal Angle Fixture shown in Fig. 4

designed so that settings over a range of 180 degrees are provided for the table. In making the different settings on the angle fixture, no working surfaces are exposed, and it is impossible for dirt or chips to find lodgement between the accurately scraped working surfaces. The fixture is intended to be clamped with two bolts to the table of the milling machine, or other surface upon which it is to be used. It will be noticed from Fig. 4 that the base is graduated, and is provided with a double vernier, so that any setting throughout the 360 degrees may be obtained accurately in degrees and minutes. By means of a geared nut and a pinion wrench, the fixture may be locked securely at any desired angle. Special attention is called to the fact that this locking is done by this one movement.

For obtaining inclinations on the fixture for various horizontal angles within a range of 180 degrees, a pinion wrench and gear are provided; and a graduation and a double vernier make it easy to set the fixture to any desired angle in degrees and minutes. Special attention is called to the method by which this angle fixture is clamped for different settings without distorting the setting. The spindle upon which the table swivels is provided with double reverse tapered ends, as may be seen in Fig. 5, and the clamping action draws these tapers together, thereby clamping the fixture. Throughout, this fixture is said to be very accurately made and intended for the finest of tool and production work. The flat surfaces are accurately scraped and the adjusting surfaces on the clamping spindle are hardened and ground. This fixture is made in three sizes, 5 by 8 inches, 8 by 12 inches, and 12 by 18 inches, these dimensions referring to the size of the table.

BLAIR THREAD GAGE MACHINES

In this article there are described a thread gage grinding machine, a thread lead testing machine which is adapted for measuring the lead of either male or female threaded work, and a pitch diameter measuring machine. It will be apparent from the illustrations that the lead testing and pitch diameter measuring machines are equipped with fluid gages. Other features of all of the machines are fully illustrated and described.

For use in tool-rooms engaged on the production of thread gages, the Blair Tool & Machine Works, Inc., 515-521 Greenwich St., New York City, is manufacturing a line of machines which are shown in the illustrations accompanying the following description. This complete line includes a thread gage grinding machine shown in Figs. 1 and 2, a thread lead testing machine which is shown measuring internal and external threads in Figs. 5 and 6, respectively; and a pitch diameter measuring machine which is illustrated in Fig. 7. These machines were designed and built under the personal supervision of Charles Hardy, general manager, and J. H. Wilhelm, chief engineer of the Blair Tool & Machine Works.

Thread Gage Grinding Machine

Fig. 1 shows a complete view of the thread gage grinding machine, together with the overhead works which are required for driving it. In connection with the following description, however, a better idea of features of the design will be gathered by referring to Fig. 2, which shows a view of this machine with the belts removed from the driving pulleys. To provide for rotating the work and traversing the grinding wheel past the work, power is transmitted from a pulley *A* through a worm and worm-wheel, which serves the double purpose of giving the desired speed reduction, and at the same time affording a particularly smooth transmission. It will be seen that the thread gage *B* which is to be ground is carried between centers, and as the work rotates, grinding wheel *C* is traversed along it at exactly the required rate to give the proper lead to the thread. The carriage which supports the grinding wheel head slides on ways on the bed of the machine, and this movement of the carriage is controlled by a master screw (the end of which can be seen at *D*) which has exactly the same pitch as the thread which is being ground. An arm on the back of the carriage carries a nut which runs in mesh with this master lead-screw to provide for feeding the grinding wheel along the work.

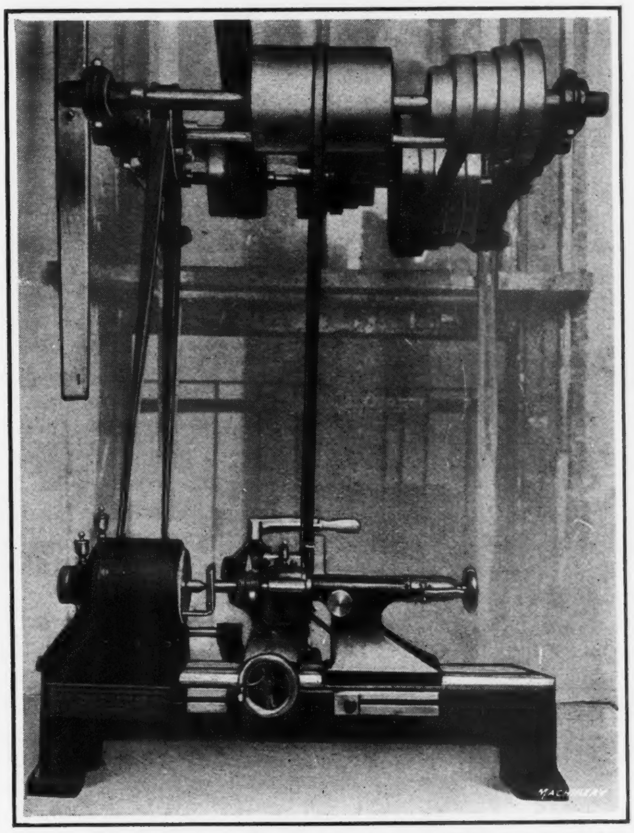


Fig. 1. Thread Gage Grinding Machine built by Blair Tool & Machine Works, showing Arrangement of Countershaft

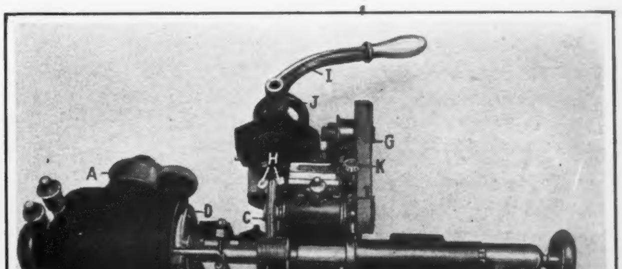


Fig. 2. Close View of Thread Gage Grinding Machine shown in Fig. 1

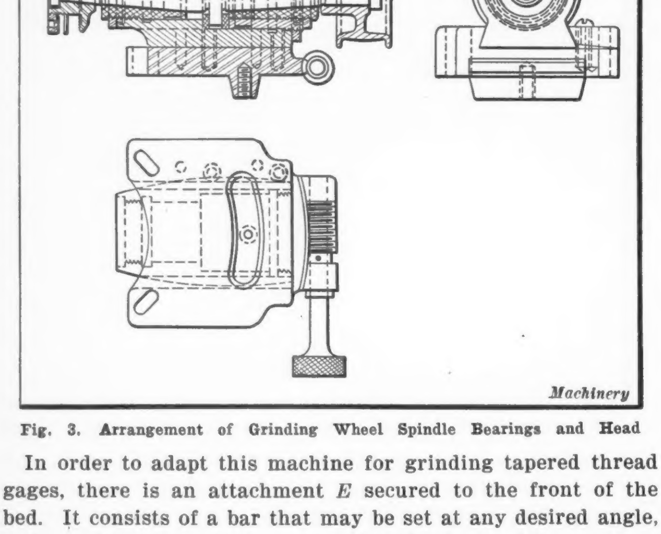


Fig. 3. Arrangement of Grinding Wheel Spindle Bearings and Head

In order to adapt this machine for grinding tapered thread gages, there is an attachment *E* secured to the front of the bed. It consists of a bar that may be set at any desired angle, and provision is made for supporting the front of the carriage on this bar, so that as the carriage is traversed along the bed, it will be raised or lowered as required, to cause the grinding wheel to follow the taper angle on the work. Thread gages ground on this machine are supported between centers, and to facilitate the changing of work, a lever *F* is provided which enables the tail-center to be pulled back against a compression spring, instead of depending upon a screw for securing this adjustment. As a result, the tail-center may be much more quickly manipulated than would otherwise be the case.

Grinding wheel *C*, which is employed to grind the thread gage, is driven by an endless fabric belt *G* that provides for increasing the speed of rotation at which the wheel runs, to give the necessary peripheral cutting speed for the abrasive. The driving pulley over which belt *G* runs, and also the pulley that is driven from the countershaft, are supported on a swinging bracket connected to a tension spring, which will be seen at the right-hand side of the cross-slide. This spring provides for maintaining exactly the required belt tension.

The grinding wheel must be trued to the exact form of the thread to be ground, and it is, of course, absolutely important to maintain exactly the required form for the wheel. This is done by means of a truing device provided with two diamond points which are carried in the holders shown at *H*. It will be apparent that one diamond engages the wheel at each side, and by swinging lever *I* backward and forward, these diamond points move across the inclined faces of the wheel, thus truing up the wheel to exactly the desired shape. At the back of the truing device there is a small handwheel *J*, which operates a screw employed for feeding the wheel into the work as its diameter is reduced.

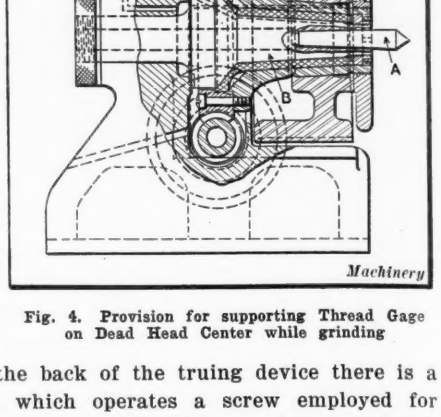


Fig. 4. Provision for supporting Thread Gage on Dead Head Center while grinding

Another important adjustment in connection with this machine is the means provided for setting the grinding wheel to correspond with the helix angle of the thread which is being ground. This adjustment is made by means of a graduated head *K*, which turns a worm *L* that runs in mesh with a worm-wheel segment secured to the grinding wheel spindle head. This head is carried by curved slides which have their center at the center of the grinding wheel. As a result of turning head *K*, the wheel is rocked slightly about its own center to provide for setting it to correspond with the helix angle of the threaded work. Graduated handwheel *M* operates the cross-slide to provide for securing exactly the necessary adjustment to obtain the required pitch diameter for the work.

Particular attention is called to the fact that the thread gage to be ground is supported on two dead centers and driven by the usual form of dog. The advantage of using two dead centers is that it assures a practically uniform support for the work and avoids danger of wear in the centers introducing inaccuracy in the results produced by the grinding operation. Reference to Fig. 4 will show the construction of the dead center at the head end of the machine. It will be apparent from this illustration that center *A* is carried by a support *B* that is secured to the frame of the machine. The lead-screw which provides for feeding the grinding wheel past the work is bored out so that it can be slipped into place

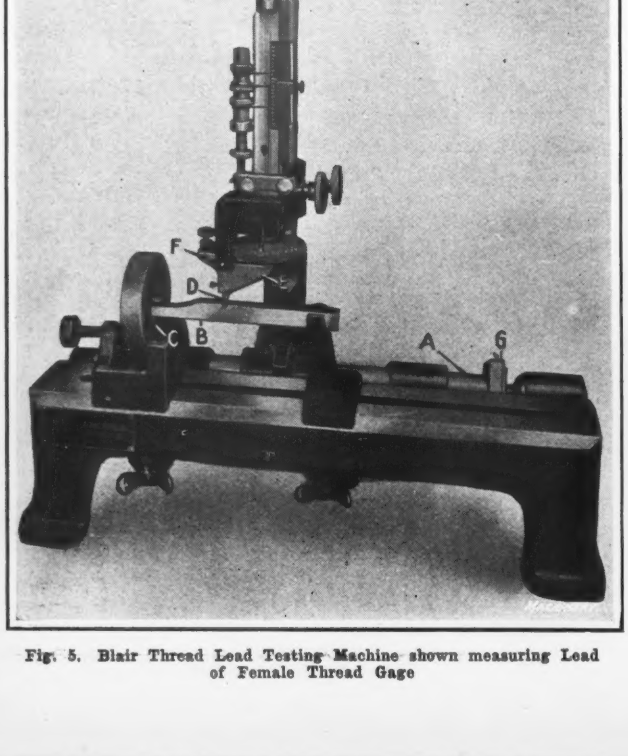


Fig. 5. Blair Thread Lead Testing Machine shown measuring Lead of Female Thread Gage

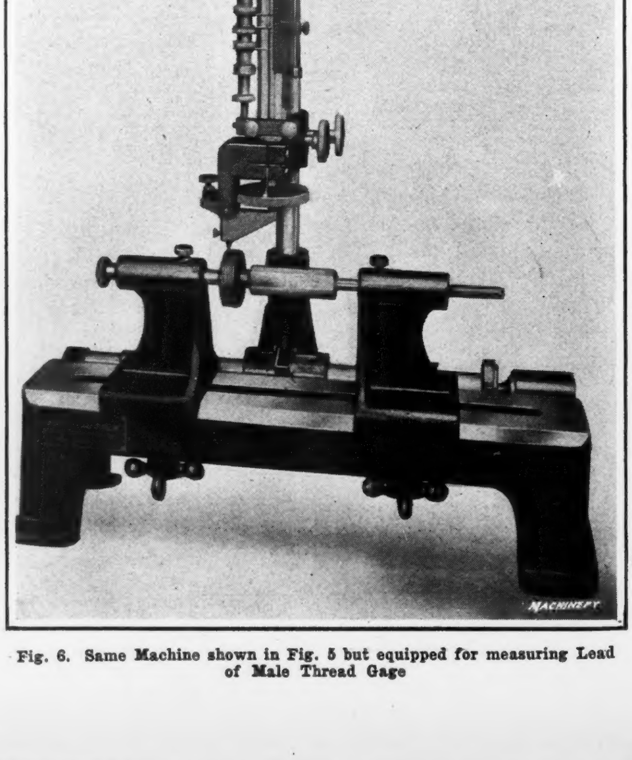


Fig. 6. Same Machine shown in Fig. 5 but equipped for measuring Lead of Male Thread Gage

without in any way interfering with the dead center or its support. The tail of the driving dog engages the rotating faceplate to provide for revolving the work while it is being ground.

Internal and External Thread Lead Testing Machines

For use in testing the lead of female thread gages and similar work, the Blair Tool & Machine Works, Inc., are now building a machine of the type shown in Fig. 5. It will at once be apparent that the gaging device used on this machine is one of the Prestwich fluid gages with which readers of MACHINERY are familiar. This gage is supported on a bracket carried by horizontal bar *A*, the arrangement being worked out in such a way that the entire gage can be pushed in a direction parallel to the machine bed, this movement being against the pressure exerted by a compression spring.

In using this lead-testing machine, the method of procedure is briefly as follows: Carried on bar *B* there is a steel stylus point *C* which is shaped to fit exactly into the thread on the work. Pin *D* engages a notch cut in bar *B*, and by rocking bellcrank *E* about pivot *F*, pressure is imparted to the diaphragm of the Prestwich fluid gage. With point *C* set in position in a thread of the gage, the inspector carefully notes the level of the liquid in the gage, and after this has been done, he lifts point *C* out of the thread and places it in either the next thread or in any convenient position. Then a Johansson gage-block *G* is selected, which is either equal to the lead of the thread or to some multiple thereof, according to whether the pin was placed in the next thread or several threads along the gage. After the Johansson gage has been put in place, the compression spring pushes sliding bar *A* back so that it is firmly in contact with the gage. It will now be apparent that if the lead of the thread is accurate, the distance which bar *B* has been moved along in order to enter point *C* into its new position will be exactly equal to the distance that bar *A* has been moved in order to admit the Johansson gage-block. As a result, the reading of the Prestwich fluid gage should be exactly the same as it was before. In the case of any error in lead, however, the level of the liquid in the fluid gage will be changed due to pressure applied by bellcrank *E*. which will be rocked about pivot *F* because of the changed position of point *C*; and the graduations on the fluid gage will then indicate the amount of error which exists in the lead of the thread gage.

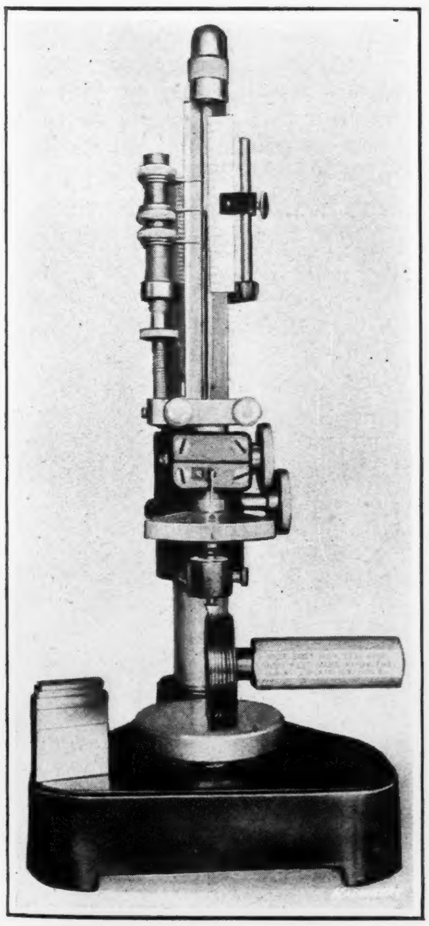
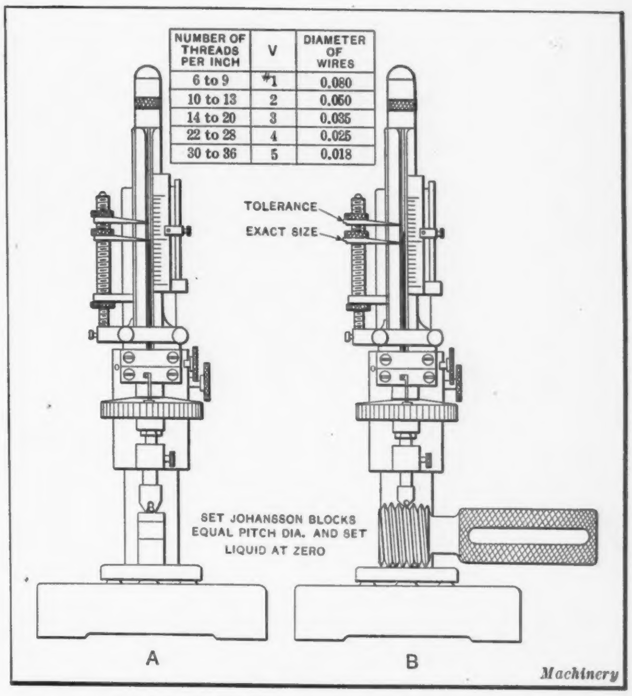


Fig. 7. Pitch Diameter Measuring Machine built by Blair Tool & Machine Works

Fig. 6 shows the same machine as the one illustrated in Fig. 5, with different centers in place to provide for testing the lead of a male thread gage. The method of procedure is exactly the same as that which has been described, except that a point carried by the bellcrank *E* enters directly into the thread on the work, instead of entering a notch cut in the extension bar that is required to reach into a female thread gage, as shown in Fig. 5. The Johansson block is some even multiple of the lead of the thread, so that when this block is put into place and the point is entered into its new position on the thread gage, the reading of the fluid gage should not be altered, if the lead of the gage is accurate.



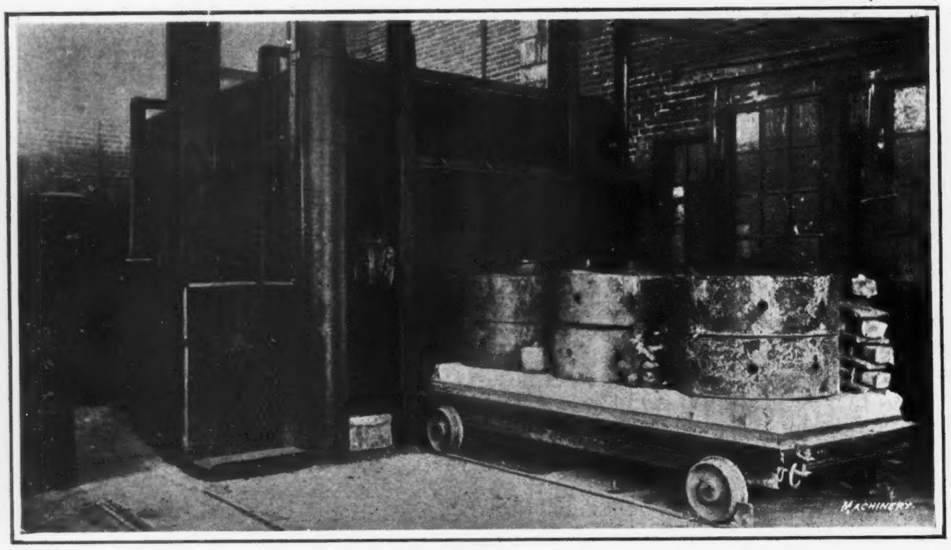
NUMBER OF THREADS PER INCH	V	DIAMETER OF WIRES
6 to 9	*1	0.080
10 to 13	2	0.050
14 to 20	3	0.035
22 to 28	4	0.025
30 to 36	5	0.018

Fig. 8. Illustration of Method of Procedure in setting Pitch Diameter Measuring Machine

Pitch Diameter Measuring Machine

Fig. 7 shows another machine built by the Blair Tool & Machine Works, Inc., on which the Prestwich fluid gage is also employed. The present machine is intended for use in testing the pitch diameter of threaded work, but attention is called to the fact that this is only a comparator which affords a rapid method of ascertaining whether an error exists, and if so, how much its magnitude may be. It will be seen that the thread gage which is under test is supported below by means of two accurately lapped wires which raise the gage from the table, and at the top there is a contact point with two V-shaped projections which straddle a thread on the work. In using this measuring machine, the thread gage to be tested is put in place as indicated, after which the reading of the fluid gage is taken. If there is any error in the diameter, this will cause the column of fluid in the gage to assume a position above or below the zero point, as the case may be, thus indicating the amount of error by the graduated scale on the fluid gage. When so desired, this machine may be used for taking actual measurements of the pitch diameter by arranging a combination of Johansson gage-blocks equal to the pitch diameter of the work and setting the fluid gage to zero from these blocks. After a setting has been made in this way, readings are taken from the thread gages, with the result that the reading of the fluid gage above or below the normal position in which it was set by the gage-blocks, indicates the amount which the pitch diameter is above or below the required size for the work.

In conclusion, attention is directed to Fig. 8 which shows the method of setting the pitch diameter comparator for measuring threaded work of a given pitch diameter. Mention has already been made of the fact that this is done by using Johansson gage-blocks which are built up to a height equal to the pitch diameter of the work. The practice followed in performing this part of the operation is shown at *A* in Fig. 8, where it will be seen that a lapped wire is placed between the gage-blocks and the 60-degree vee which transmits pressure to the Prestwich fluid gage. After adjusting the height of the column of the fluid gage to the zero point for the setting shown at *A*, two lapped wires are placed under the thread gage, as indicated at *B* and one of the threads of the gage is passed through the vee. Then, if the work is accurate, the column of liquid in the fluid gage should return to the zero point, as it was for the setting at *A*.



Electrically Heated Annealing Furnace installed in Plant of Otis Elevator Co. by Electric Furnace Co.

ELECTRIC HEAT-TREATING FURNACE

In the accompanying illustration is shown an electrically heated annealing furnace which was built and installed at the plant of the Otis Elevator Co. in Buffalo, N. Y., by the Electric Furnace Co., of Alliance, Ohio. This is a 150-kilowatt furnace and is known as the "car" type, because the pieces which are to be annealed are loaded on a car, as shown in the illustration, after which the furnace door is raised and this car is pushed into place and left in the furnace during the period required to heat-treat the work to give it the desired physical properties. It will be seen that the top of the car is covered with firebrick. This furnace has a capacity for annealing 1000 pounds of steel castings per hour.

Research work conducted by metallurgists and chemists has shown the most desirable temperatures to employ for performing the various heat-treatments that are applied to steel and certain other metals. Almost every plant has fairly definite knowledge concerning the proper temperatures to employ in heat-treating their work so that where trouble is experienced it is more often due to difficulty in obtaining and maintaining the proper temperature than to any lack of information concerning what is the correct temperature to use. The great advantage claimed for electric furnaces which are used for the performance of heat-treating operations is that the maintenance of a uniform temperature in all parts of the furnace is said to be an easier matter than in the case of furnaces that are heated in other ways.

AUTOMATIC ELECTRICAL SCREWDRIVER AND AIRPLANE DRILL

A feature of importance in the design of the electrically driven screwdriver shown in Fig. 1 is that it is provided with a mechanical automatic burn-out protection device which immediately shuts off the current if the tool becomes overloaded, making a burn-out impossible. There are no fuses to replace or anything to do after the current is shut off, except to pull out the switch again and start the tool. The weight is only five pounds, so that the screwdriver is light enough to be taken anywhere and still it is powerful enough to drive any screw that could be driven with a hand brace. It is stated that a No. 14 screw, 2½ inches long, can be driven into oak without first drilling a hole to receive it and without danger of burning out the motor through overloading.

Another feature is that the tool provides for driving screws either in or out without having to make any changes in the arrangement of the mechanism. This result is accomplished through the provision of a right-hand and of a left-hand spindle, so that the proper spindle is used according to whether a screw is to be driven in or withdrawn. The bit does not revolve until it is placed in the screw slot, and downward pressure is applied to engage a positive driving clutch. As the idle spindle does not revolve, there is no danger of its injuring the operator. These tools are adapted for such purposes as making ammunition boxes, automobile bodies, furniture, etc., in which use they are the means of effecting a substantial saving of labor.

Fig. 2 shows a tool which is styled an "airplane drill," owing to the fact that it was developed to meet certain requirements in British airplane factories. The weight is only 3½ pounds, and the tool is said to fit nicely into the hand so that it is convenient to operate. The capacity is for drilling holes in brass or aluminum up to 1/8 inch in diameter, and holes may be drilled in wood up to 1/4 inch in diameter. The motor runs at 10,000 revolutions per minute and is air-cooled by a powerful fan. The chuck is screwed directly onto the armature shaft and is mounted on ball bearings. A two-pole type of switch is mounted in the handle. This drill may be operated on either alternating- or direct-current circuits and is provided with a 10-foot connecting cord. Both of these machines are made by the Automatic Electrical Tool Co., and they are sold by George C. McKay, 4247 Greenlee Ave., Cincinnati, Ohio.

ELECTRO-STYLOGRAPH ELECTRICAL ETCHING MACHINE

The Electro-Stylograph Co., Metropolitan Tower, New York City, is now making an apparatus known as the "electro-stylograph," which writes indelibly on metal. In addition to its application in marking tools, this equipment may be employed to advantage for marking metallurgical test specimens and for placing the passed or rejection marks on government

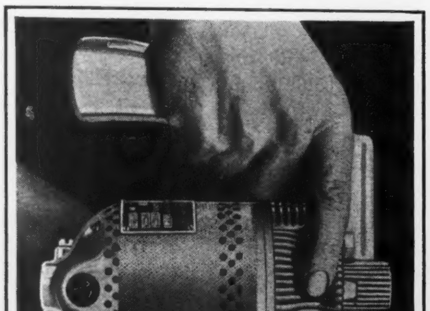


Fig. 1. Automatic Electrically Driven Screwdriver sold by George C. McKay

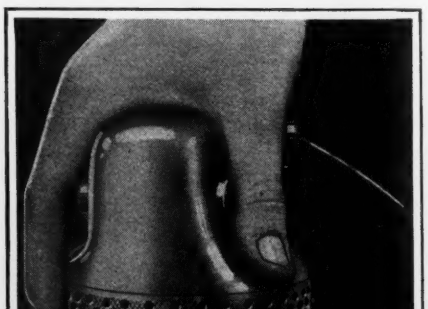


Fig. 2. Automatic Electrically Driven Airplane Drill sold by George C. McKay

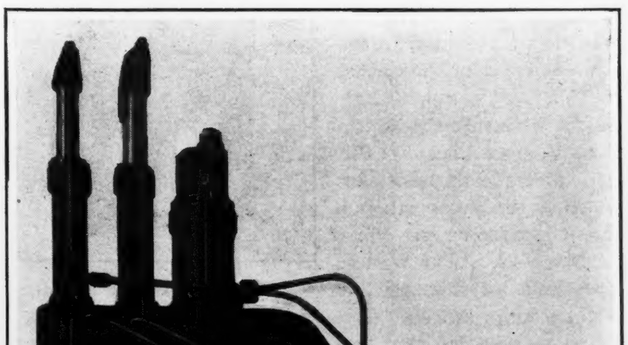

Electro-stylograph made by Electro-Stylograph Co., for Use in marking Tools, Gages, Dies, etc.

work after it has been gone over by inspectors. For marking tools and metallurgical specimens, a particular advantage of this method of marking is that it does not set up any internal strains in the metal.

Marking with the electro-stylograph is accomplished by utilizing the well-known principle of localized surface fusion produced by resistance to the flow of electric current of low voltage and high amperage from the stylus to the piece which is to be marked. The apparatus is designed in such a way that delicate control is afforded so that the writing may be varied from a fine hair line to about 1/16 inch in width. This control is so effective that even thin steel instruments may be marked without danger of burning. The method of marking is comparable to writing with an ordinary pen or pencil, and the procedure will be readily understood by reference to the accompanying illustration. The amount of current consumed is approximately the same as that required to operate an ordinary incandescent light. Connection is made with an ordinary electric light circuit of 110 volts and 60 cycles alternating current. Special outfits may be supplied for use on other voltages and for use on direct-current circuits.

SOUTHWARK FOUR-RAM HYDRAULIC FLANGING PRESS

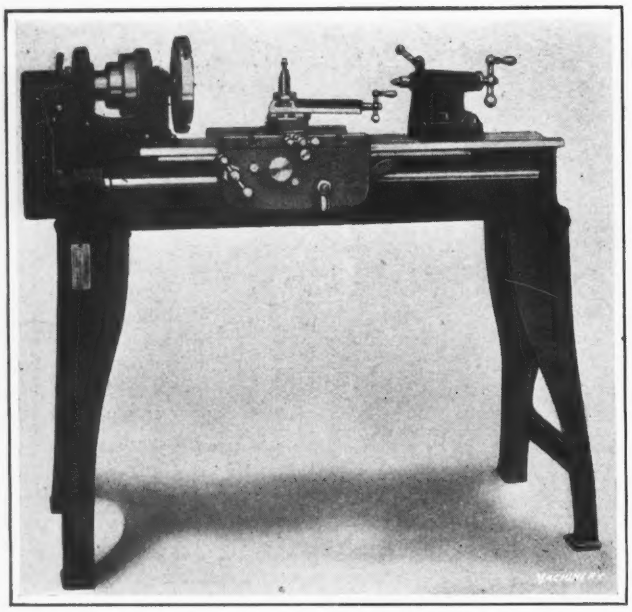
A special four-ram hydraulic flanging press has recently been developed by the Southwark Foundry & Machine Co., Philadelphia, Pa., for the bending of the plate and flanging and upsetting the ends of spiral-riveted pipe. This machine is provided with two vertical and one horizontal cylinder, similar in construction to those employed on sectional flanging presses, but, in addition, a vertical cylinder is provided which, during the operation of the horizontal cylinder, lifts its operating end or ram in a manner required by the dies provided for the work to be performed. These dies are not shown in the illustration. The outside vertical ram has a capacity of 75 tons, the middle vertical ram has a capacity of 150 tons, while the third vertical ram, operating a bending horn which is located inside the stationary horn, will exert a pressure of 150 tons. The separate flanging or upsetting ram which is actuated by the horizontal cylinder has a capacity of 150 tons.


Four-ram Hydraulic Flanging Press built by the Southwark Foundry & Machine Co.

The machine is operated by one valve for each cylinder, the four valves being operated separately. The main ram works under a pressure of 1500 pounds per square inch, but the vertical rams may also be worked under a pressure of 750 pounds per square inch, these rams being provided with two-pressure valves. The pull-back rams work under a pressure of 750 pounds per square inch. All the rams are outside-packed, and flax packing is used throughout. All the castings, except the rams, are of cast steel, the rams being made from close-grained cast iron.

SEBASTIAN ENGINE LATHE

One of the recent products of the Sebastian Lathe Co., Cincinnati, Ohio, is the 10-inch engine lathe which is shown in the accompanying illustration. It will be seen that the headstock is equipped with a three-step cone pulley, which carries a belt 1¼ inch wide and has steps 5½, 4, and 2½ inches in diameter, respectively. The back-gear is engaged or disengaged by means of a cam, and to reverse the feed of the lathe for screw-cutting, a handle is operated at the end of the headstock. The spindle is made of steel and accurately ground to size; it is supported in phosphor-bronze boxes. To provide for the performance of taper-turning operations, an adjustable sliding movement is furnished for the tailstock. The tailstock has a spindle 1 1/16 inch in diameter that is carefully ground to an accurate fit. It will be seen that the tailstock is of the under-cut pattern, which allows the compound rest to be swung at right angles to the faceplate. Large T-slots are provided at the front and rear of the carriage, which is gibbed to the bed and brought into accurate alignment. An interlocking mechanism is provided in the apron which prevents both feeds from being simultaneously engaged. The lead-screw is accurately cut and provided with a spline groove for feeding in all cases except where the lathe is used for the performance of thread-cutting operations. Power cross-feed is provided, and there is a graduated dial on the cross-feed screw. The regular equipment furnished with each lathe includes a friction countershaft, steadyrest, follow-rest, compound rest, faceplates 5 and 9 inches in diameter, change-gears to provide for cutting all standard threads from 3 to 40 per inch, and the necessary wrenches for making all adjustments. When so desired, the lathe can be furnished with bench legs



Ten-inch Engine Lathe built by the Sebastian Lathe Co.

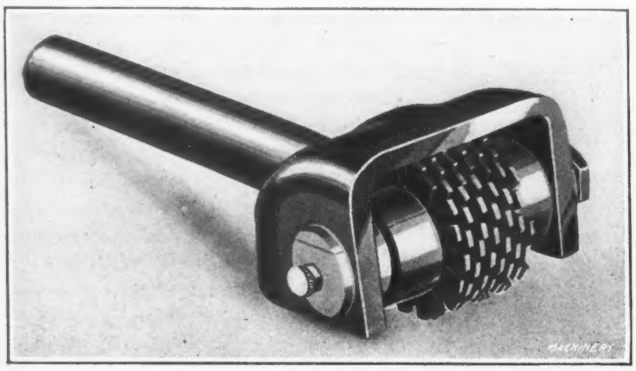
and with a foot motion in place of the countershaft. Extra attachments that are available for use in this lathe are as follows: A plain tool-block, a taper attachment, a set of ten metal-turning tools, a set of wood-turning tools, a hand rest, a set of raising blocks, a milling attachment and chucks, a set of special centers, and provision for individual electric motor drive.

The principal dimensions of the machine are as follows: Swing over bed, 11 inches; swing over carriage, 7 3/4 inches; lengths of bed, 4, 5, or 6 feet; dimensions of front bearing, 1 5/16 by 2 1/2 inches; diameter of hole through spindle, 1/2 inch; width of driving belt, 1 1/4 inch; capacity between centers for machine with 4-foot bed, 28 inches; size of tools, 3/8 by 5/8 inch; maximum travel of compound rest, 3 3/4 inches; capacity of center rest, 3 inches; taper of centers, No. 2 Morse; dimensions of countershaft pulleys, 6 by 2 1/2 inches; recommended speed for countershaft, 200 R.P.M.; and weight of machine, 450 pounds.

H. P. GRINDING WHEEL TRUING TOOL

In the New Machinery and Tools section of the May number of MACHINERY, descriptions were published of three grinding wheel truing tools made by the H. P. Co., 45-47 E. Fort St., Detroit, Mich. Tools of this kind were made for truing grinding wheels used for the performance of roughing and semi-finishing operations. The company now announces the addition to its line of a ball bearing type of grinding wheel truing tool, which is claimed to be adapted for any work of wheel truing for which diamonds are commonly employed; that is to say, the tool is adapted for truing wheels used for roughing, semi-finishing, and finishing operations.

These improved grinding wheel truing tools are of the ball bearing type, which reduces friction to a minimum and permits a perfect adjustment, provision being made to maintain accurate adjustment during the life of the cutter with which the tool is equipped. Tools of this type may be used either wet or dry, and the improved cutters with which they are equipped are built up of fifteen sections each 1/16 inch in thickness with teeth 5/16 inch deep, which are rigidly mounted so as to form a spiral toothed cylinder. It is claimed that each cutter will perform approximately 1000 truing operations on a wheel 24 inches in diameter by 3 inches face width. The ball bearings used are of the "Norma" type and provide accuracy, efficiency, and long life for the spindle bearings. The tool shown in the accompanying illustration is of the type that is adapted for truing grinding wheels used for the performance of roughing and semi-finishing work.



H. P. Ball Bearing Type of Grinding Wheel Truing Tool

GENERAL ELECTRIC "SAFETY-FIRST" INDUCTION MOTOR PEDESTALS

In many manufacturing operations, safety and efficiency are so related that an improvement in either condition usually effects an improvement in the other. More and better work is produced when light, air, sanitation, and the disposition of machinery are such that working conditions are pleasant and healthful, and comparative freedom from liability to occupational or accident disability exists. In connection with the requirements of safety, the panel illustrated in Fig. 1, which is a recent development of the General Electric Co., Schenectady, N. Y., is of considerable interest. It is adapted particularly to the control of alternating-current feeder or motor circuits in capacities up to the rating of the FK-20 oil circuit breaker, namely, 300 amperes and 2500 volts.

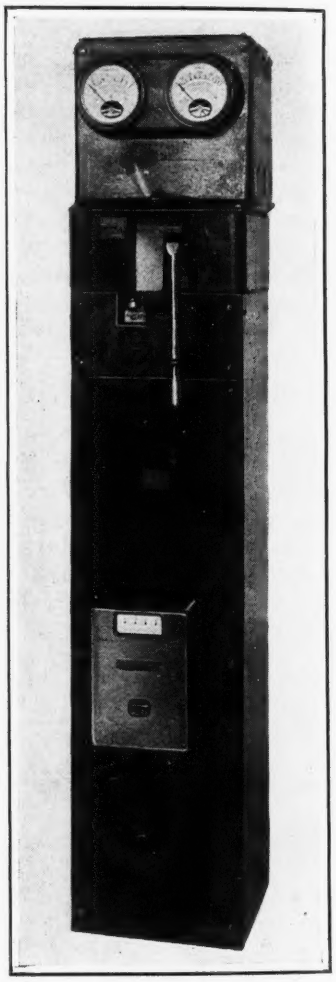


Fig. 1. General Electric Induction Motor Pedestal

By referring to Fig. 2, it can be seen that the unit consists of a Type FK-20 oil circuit breaker mounted on a pedestal constructed of steel plates and angle-iron, the former holding the latter in position and serving as mountings for the apparatus in the interior of the pedestal. The compartment immediately beneath the breaker and surrounded by the steel plates is used for mounting the potential and current transformers. The space above the switch serves as a housing for the disconnecting switch, and also provides a location for either voltmeter or ammeter or both when desirable. Other instruments, such as watthour meters, etc., may be mounted on the sheet-steel front of the panel. The back of the pedestal is also a sheet steel plate, removable to allow access to the interior.

The voltmeter and ammeter are mounted on a cast base above the breaker, and with the front edges of the instruments flush with the casting. Back of the instruments in the interior of the housing are spring contacts which make contact with the instrument studs, so that, after removing the holding screws, the instruments can be removed from their support without disconnecting the leads. When the instruments are replaced, the connections to them are made automatically. The instrument resistances are mounted behind the instruments. The watthour meter is mounted on the lower front of the pedestal. The studs run through insulating bushings to the interior, where they are connected to the leads from the current and potential transformers, which are

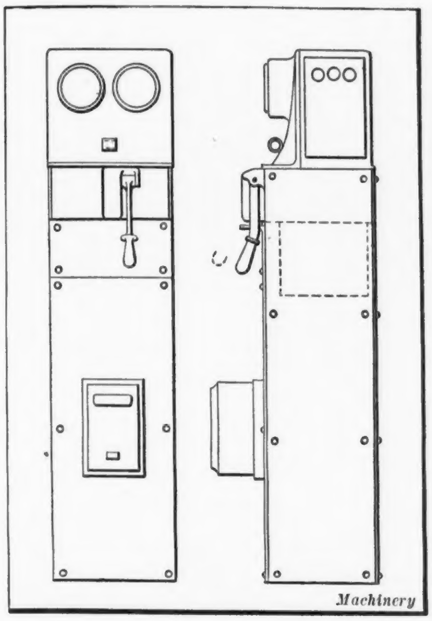


Fig. 2. Front and Side Views of Pedestal shown in Fig. 1

mounted on strap-iron supports connecting the angle-iron uprights. The drilling of the supports permits mounting either one or two current and potential transformers without additional drilling.

This FK-20 oil circuit breaker is operated in the usual manner by an iron handle from the front. Automatic protection is obtained by two-series overload coils provided with dash-pot time-limit trip. The under voltage release weight hangs in the small space shown, and the oil circuit breaker can be operated only when the disconnecting switch is closed.

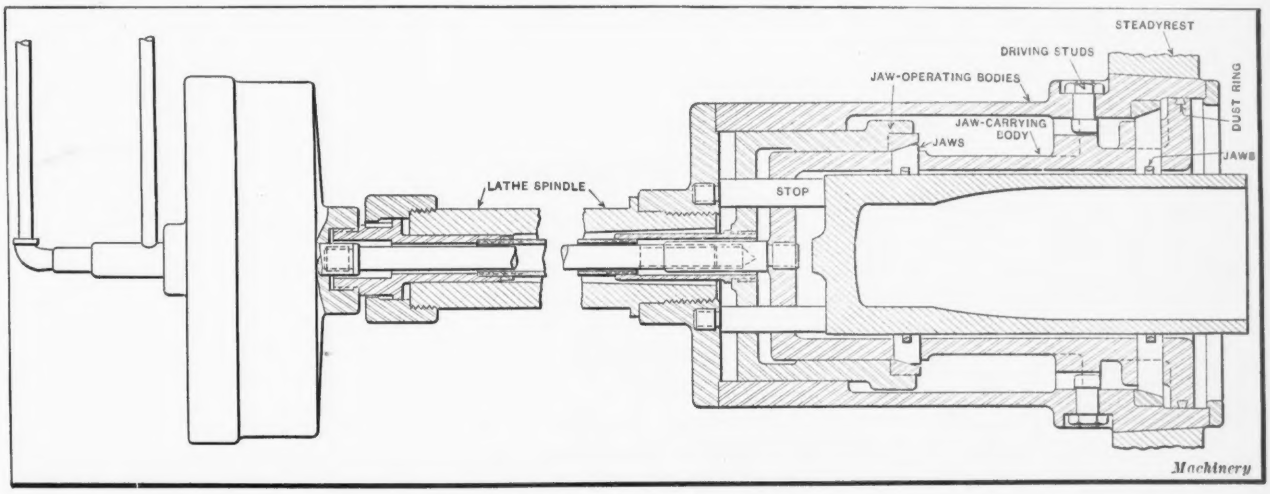
This disconnecting switch is operated from the front of the pedestal by a removable handle, so interlocked with the oil circuit breaker that the disconnecting switch can be operated only when the breaker is open. The breaker can thus be cut out of service at any time when open, and can be inspected or repaired without danger. The oil tank cannot be taken off the breaker nor can the cover over the disconnecting switch be removed unless the disconnecting switch is open. The disconnecting switch and the oil circuit breaker can both be locked open by removing the disconnecting switch handle. This handle can be removed or attached only when the disconnecting switch is open.

It is impossible to get at the live parts of any of the apparatus until portions of either the back or the front of the pedestal have been removed. These panels occupy small space and are easy to install. Pedestal type units are designed for single or group mounting and have a large bus compartment just above the disconnecting switch and inside the cast-iron housing. Connections run either to the top or the bottom of the pedestal, but as a rule the leads enter from the bottom, as this is generally the more convenient arrangement. After being put into place the pedestals are secured by bolting to the floor.

PRODUCTION SHELL CHUCK

To meet the requirements of shops engaged in the manufacture of shrapnel and high-explosive shells, the Production Appliances Co., 14 S. Jefferson St., Chicago, Ill., has recently placed on the market the "Paco" compensating shell chuck which is illustrated and described herewith. Reference to the illustration will show that there are two sets of jaws in this chuck, which are operated independently of each other and grip the shell at points near the ends, thus automatically aligning it with the lathe spindle. Positive connection is provided between the jaw-carrying and jaw-operating bodies and the lathe spindle, by means of driving and stop studs, which provide for utilizing the full power of the air for gripping the work. As a result, the chuck can be used for both roughing and finishing operations without straining any of its parts.

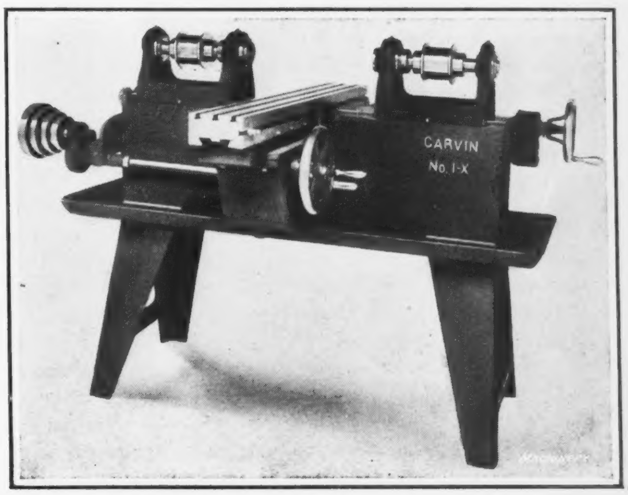
The chuck jaws are carried by a continuous round body, in which openings are machined to receive the jaws and snugly fitting studs. The jaws completely disappear when the chuck is ready to receive the shell, making it easy for the operator to slip the work into place without taking time to avoid the protruding edges of the jaws. Another important feature is the provision of a dust ring which effectually prevents dirt and grit from entering between operating surfaces, where it would cause rapid wear. It will be apparent from the illustration that this chuck is of rugged and simple design, without any delicate parts which are likely to break or get out of adjustment.



"Paco" Shell Chuck made by Production Appliances Co.

GARVIN DUPLEX MILLING MACHINE

A No. 1X duplex milling machine, which is shown in an illustration which accompanies the following description, is one of the recent additions to the line of machine tools built by the Garvin Machine Co., Spring and Varick Sts., New York City. Simultaneous wheel control to the spindle heads is provided so that both heads may be moved at the same time, and provision is also made for independent head adjustment. A maximum feeding movement of 34 inches is provided for the table, and the distance between the spindle heads is 22 inches, this increase in dimensions permitting the machine to handle



No. 1X Duplex Milling Machine built by Garvin Machine Co.

pieces of considerably larger size than it is possible to do on the regular No. 1 duplex milling machine built by this company.

Several important advantages are claimed for the duplex type of milling machine, among which the following may be mentioned: Parallelism of the work is assured and the butt or face cutters are said to give a finer finish to the work; and they can be operated under a good stiff rate of feed without sacrificing the quality of the finish. Two sides of the work are finished simultaneously, and there is no scoring of the finished surface, due to the drag and spring of straddle milling cutters, because the cutters are located close to the ends of the spindles. The work can be stacked up and the same operation performed on all pieces at a single cut.

This No. 1X duplex milling machine is designed to meet the requirements of plants engaged in the manufacture of standard parts, such as hardware specialties, brass goods, typewriters, cash registers, and similar products. There is ample space on the table for mounting fixtures; and power feed is provided with automatic trip and quick return of the table by means of a handwheel. Changes of feed are secured by means of a cone pulley driven from the countershaft. This machine can be provided with a pump and piping for delivering a supply of lubricant to the cutters and the work.

GENERAL ELECTRIC REMOTE CONTROL STARTER FOR SMALL INDUCTION MOTORS

There has always been a demand for a device for starting small induction motors from remote points by throwing them

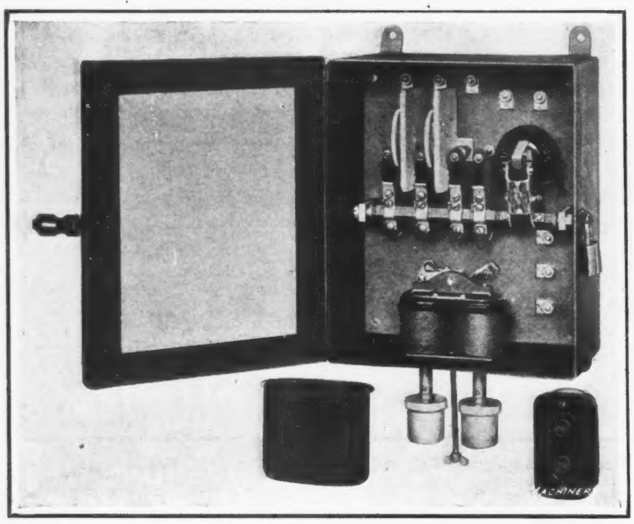


Fig. 1. General Electric Remote Control Starter for Small Squirrel Cage Induction Motors

directly across the line. The General Electric Co., Schenectady, N. Y., has recently developed and placed on the market such a starter, known as the CR-7006 remote control switch, arranged for push-button control. This starter is applicable for use with motors up to and including 5 horsepower, 11 volts, and 7½ horsepower, 220, 440, and 550 volts. In addition to its starting function it provides protection against undervoltage and overload. The device consists of a 25-ampere, 3-pole, contactor with two inverse time limit gravity reset overload relays mounted on a slate base totally enclosed in a strong sheet-iron case.

A small "start and stop" push-button station is used as a remote control switch. Completion of the starting circuit, by pressing the "start" button energizes the coil of the magnetically operated switch, closing the contacts, which throw the motor directly on the line. Interruption of the circuit or a radical decrease in voltage permits the contacts to reopen by gravity, thus stopping the motor which cannot start again until the "start" button is pressed. The overload relays can be adjusted for various values ranging from normal up to 50 per cent above normal. They can also be adjusted over a wide range of time values. The relay trips automatically and resets

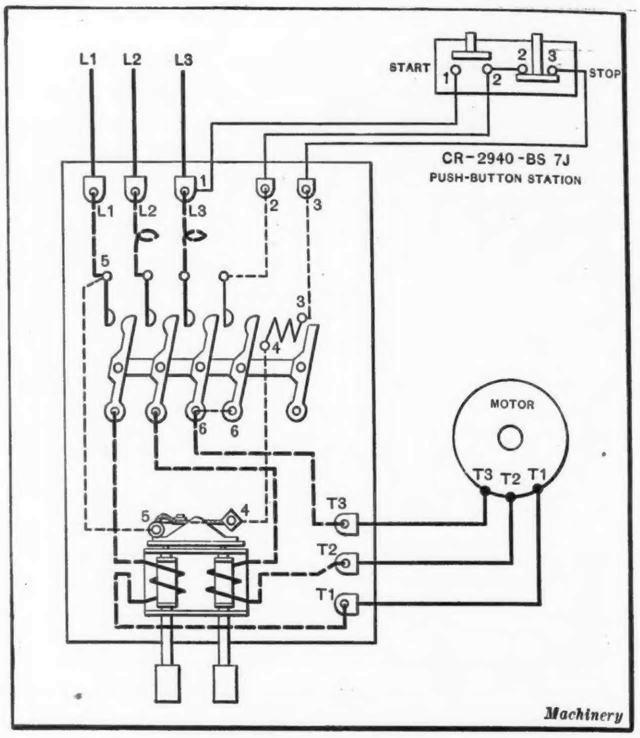


Fig. 2. Diagram showing Wiring and Connections of Remote Control Starter shown in Fig. 1

by gravity. The cover of the enclosing case is furnished with a hasp so that if desired it can be locked in a closed position by padlock.

MOLINE BOSS FACING MACHINE

To provide for back-facing the various bosses on cylinders, crankcases, and similar parts of automobile and airplane engines, the Moline Tool Co., Moline, Ill., has recently placed on the market the machine which is here illustrated and described. Although this is quite a simple operation, considerable trouble and delay has sometimes been occasioned in developing a satisfactory method of handling such work, and it is claimed by the builders of this machine that it enables boss facing operations to be very satisfactorily performed. The machine is adapted for facing all bosses on the work which are located near enough to the edge so that they may be reached by a milling cutter or where the boss is not located in a sharp angle, which prevents the entrance of the milling cutter. The machine consists of a bed, a slide for carrying the master plate on a vertical spindle, and an inverted cutter-spindle. The work to be faced is located by pins on the master plate, which make it unnecessary to clamp the piece down. The master plate has notches around its edge, the locations

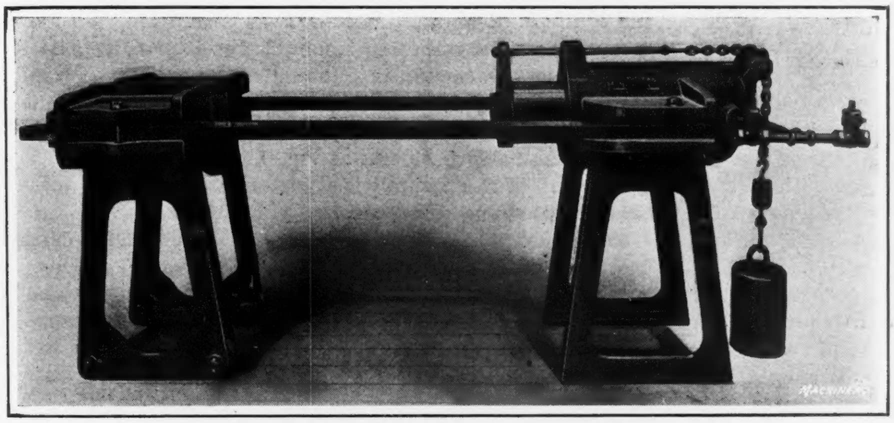
Machine built by Moline Tool Co. for facing Bosses on Cylinder Blocks, Crankcases etc.

of which correspond to the positions of the bosses to be faced; these notches engage with and are guided by a roller mounted on the cutter-spindle below the cutter.

The operation of this machine is said to be quite simple. It is merely necessary for the operator to bring the notches in the master plate successively into line with the guide roller and advance the work to the cutter by turning a pilot wheel. In some cases, it is found desirable to make slight changes in the design of the castings, keeping all the bosses of a uniform height, and changing the ribs to enable the bosses to be more readily reached by the milling cutter. A vertical adjustment is provided on the cutter-spindle to afford compensation for wear of the cutter and to allow for different heights of bosses. This spindle is driven by spiral gears. The vertical spindle for the master plate has ball thrust bearings, which greatly reduce frictional resistance and make the spindle easy to turn. The master plate may have the notches cast into it, and where this practice is followed, the edges will require only a small amount of finishing with a file.

SOUTHWARK 60-TON FORCING PRESS

A driving-box press for railroad work, known as a sixty-ton forcing press, has recently been brought out by the Southwark Foundry & Machine Co., Philadelphia, Pa. The machine is hydraulically operated, a 9-inch leather-packed ram being provided in the horizontal cylinder shown to the right. The forward stroke is accomplished under an accumulator pressure of 2000 pounds per square inch, while the pull-back is operated by a counterweight and chain, as indicated. The back head, which takes the full pressure when the machine is operated, is connected to the main head by rectangular connecting bars, 4 inches wide by 1½ inch thick. It is mounted on rollers and is adjustable with relation to the main head, the minimum space between the two heads being two feet, and the maximum space, four feet. The distance between the connecting bars is 22 inches.



Sixty-ton Forcing Press built by Southwark Foundry & Machine Co.

WILMARTH & MORMAN UNIVERSAL GRINDING MACHINE

The Wilmarth & Morman Co., 1180 Monroe Ave., N.W., Grand Rapids, Mich., is now building a No. 0 combination cutter, reamer, and drill grinding machine designed for use in shops and manufacturing plants having need of a universal tool-room grinder of medium capacity. It can be furnished for either belt drive, as shown in Fig. 1, or motor drive, as shown in Fig. 2. In the motor-driven type a 1-horsepower General Electric motor is mounted on the column, and provision for either direct current or alternating current can be supplied. As will be seen in Fig. 1, the machine is a combination of the "Yankee" drill grinder and the "Universal" grinding machines which are regular products of this concern. All spindles are equipped with ball bearings. The table slides have dust guards and are provided with taper gibs to take up wear. The saddle and knee swivel inside the sleeve, and may be set so that the main table can be set at any angle within 350 degrees and the top table to any angle within 360 degrees.

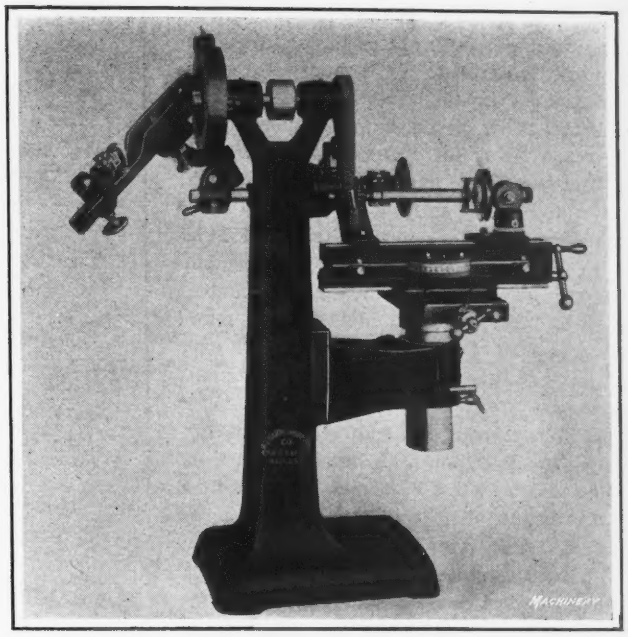


Fig. 1. Wilmarth & Morman No. 0 Universal Cutter, Reamer, and Drill Grinding Machine. In this View the Machine is shown equipped for Belt Drive

For taper grinding, the table has fine adjustment by means of two knurled-head screws at the front of the table. The headstock has both horizontal and vertical swivels graduated to read in degrees and is provided with a 1½-inch hole for a No. 2 taper collet. Fine vertical adjustment can be obtained by a handwheel provided with a graduated dial. The universal vise has two swivels and a sliding movement, which, in combination with the vertical micrometer adjustment of the table, allows the work to be brought into almost any conceivable position. The "Yankee" drill grinder is so designed that no adjustment other than that of the tailstock is necessary in the setting of the machine for properly grinding all sizes and types of drills. The point of the drills ground on this machine will be accurately centered and each cutting lip will have the same angle. The method of varying the clearance angle is simple and accurate.

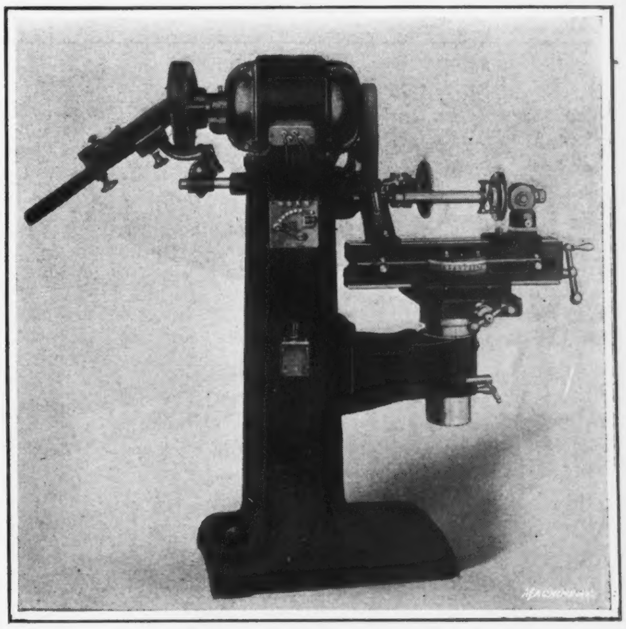


Fig. 2. Wilmarth & Morman No. 0 Universal Cutter, Reamer, and Drill Grinding Machine equipped with Individual Electric Motor Drive

The principal dimensions are as follows: Longitudinal movement of table, 12 inches; vertical movement, 6 inches; transverse movement, 6 inches; centers swing work up to 8 inches in diameter by 17 inches long. The capacity is for grinding face and side milling cutters up to 16 inches in diameter; angle and plain milling cutters, up to 8 inches in diameter; gear-cutters and hobs, up to 5½ inches in diameter; forming cutters, any size up to 5½ inches in diameter; flutes of taps, up to 12 inches long; reamers, straight or tapered, up to 17 inches over all, having flutes not over 12 inches long; cylindrical work, up to 8 inches in diameter by 12 inches long. Drill holders can be furnished in three sizes, holding drills from No. 52 to 5/8 inch, 3/32 to 1¼ inch, 1/4 inch to 2¼ inches. The vise jaws are 4 inches wide, 1⅛ inch deep, and open 2⅜ inches. The capacity of the chuck is 3 inches. The main spindle speed is 1600 R.P.M.; small spindle speeds, 3800 and 8800 R.P.M.; speed of countershaft, 530 R.P.M. The pulley on the main spindle is 4 by 2½ inches; tight and loose pulleys, 6 by 2¼ inches; driving pulley, 12 by 2¼ inches. The floor space occupied is 42 by 67 inches, and the net weight of the machine is 620 pounds.

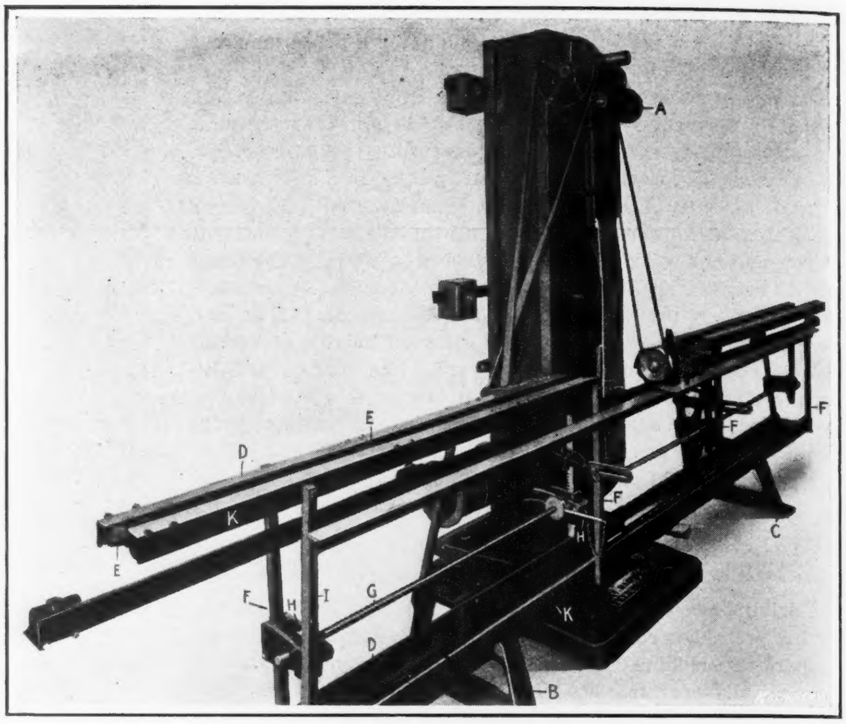


Fig. 2. Rear View of Blevney Abrasive Belt Polishing Machine shown in Fig. 1

BLEVNEY "TYPE A" TUBE POLISHING MACHINE

The Blevney Machine Co., Greenfield, Mass., has brought out a polishing machine provided with an attachment for polishing tubing, this attachment being equipped with an automatic feed and a heavy fixture for holding the tubes. The machine is intended for polishing tubing and round work of all kinds, whether the material be steel, brass, rubber, or anything that requires polishing. The machine is much heavier than similar machines brought out by the Blevney Machine Co. for tube polishing in the past. The base is about three times as heavy, and the column, as well as the base, is entirely redesigned, the total weight of the machine having been about doubled. A hub has been brought out from the column for mounting the lower pulley so that the latter is supported properly against the belt pull, the hub entering inside the pulley to such an extent that the support is practically central. The countershaft has been changed to include an idler pulley at *A* to provide the proper belt tension for the belt that drives the feed-roll. The latter has been provided with a bearing practically the full length of the roll, this bearing being filled with grease. The feed-roll is so mounted that it is adjustable for different feeding speeds in either direction, and it may also be set straight or in what might be called a neutral position, so that it will not feed in either direction, this being required when polishing such objects as tap shanks, for example. The adjustment of the feed-roll is accomplished by simply loosening and tightening set-screws.

The heavy tube-supporting fixture is novel in its design. The fixture rests upon two feet castings *B* and *C*, onto one of which—that shown at *B* next to the machine—is mounted a frame *D* of wrought-steel shapes. On the upper angle-irons of this frame are mounted a number of supporting or guide rollers *E*, which are set at an angle corresponding to that of the feed-roll. These rolls support the inner side of the tube, or the side which is next to the polishing belt when the tube is in place. The face of these guide rollers is so set with reference to the polishing belt surface that there is a clearance of 1/8 inch between the face of the polishing belt and the tube, when this is laid against the rollers; hence, when first placed in position, the tube will not touch the belt.

A series of brackets *F* are connected to the vertical section of this frame. These brackets support a pinion shaft *G* and also rocking or pivoting guides *H*, in which are mounted the rack bars *I*, which mesh with pinions on the pinion shaft. At the upper part of the rack bars is mounted another angle-iron *J*, provided with guide rollers similar to the rollers *E* which support the under side of the tube. A ratchet and pawl device on the pinion shaft serves to raise, lower, and secure the rack bars in unison, and in adjusting the rack bars, the location of the lower guide rollers is, of course, also adjusted.

At the front of the machine a frame *M*, Fig. 4, similar to frame *D*, is placed in a space provided for it in the feet, giving it an opportunity to rock. This frame is also provided with guide rollers supporting the outer side of the tube. On this frame is also mounted the feed-roller which moves the tube along in front of the polishing belt.

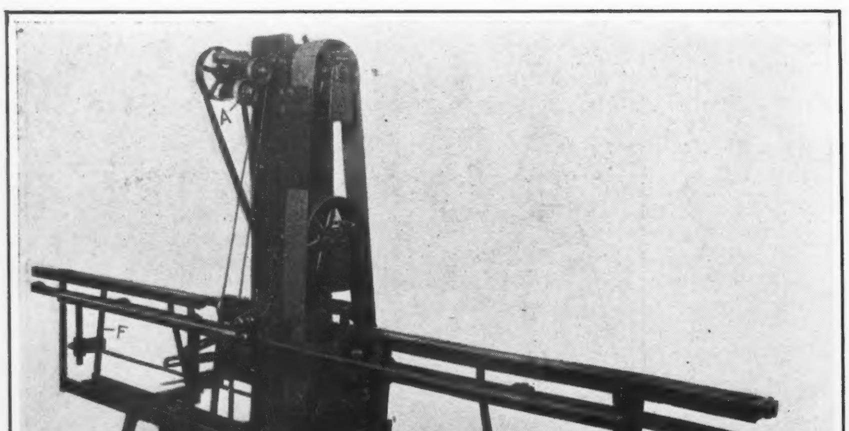


Fig. 1. Blevney Abrasive Belt Polishing Machine equipped with Attachment for handling Tubing

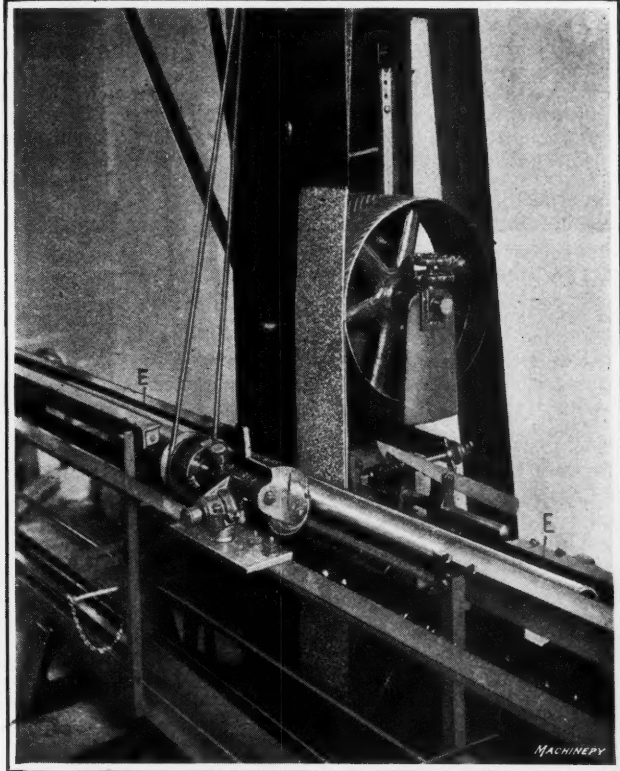


Fig. 3. Close-up Front View of Blevney Polishing Machine

The operation of the machine is as follows: Adjust by means of the pinion shaft the guide rollers attached to it so that the latter strike or touch the tube centrally on the lower side while the guide rollers on the fixture also support the tube centrally. Bring the front frame with its guide rollers to the tube and secure both the adjustable members with the thumb-nuts and lugs *L* provided for the purpose. The feed-roller moving with the front member of the frame will then be in a normal position for all sizes of tubing. A separate adjustment, however, is also provided for the feed-roller, if required. The tube is now laid in position in the fixture and the foot-pedal is pressed down. This brings the belt into the grinding position, and the tube is automatically fed past the belt by the pressure between the polishing belt and the feed-roller. A hook is provided so that the foot-pedal can be locked, which permits the operator to remove his foot, thus giving him an opportunity to prepare another tube to be laid in the fixture or remove the tube already ground while the machine is running.

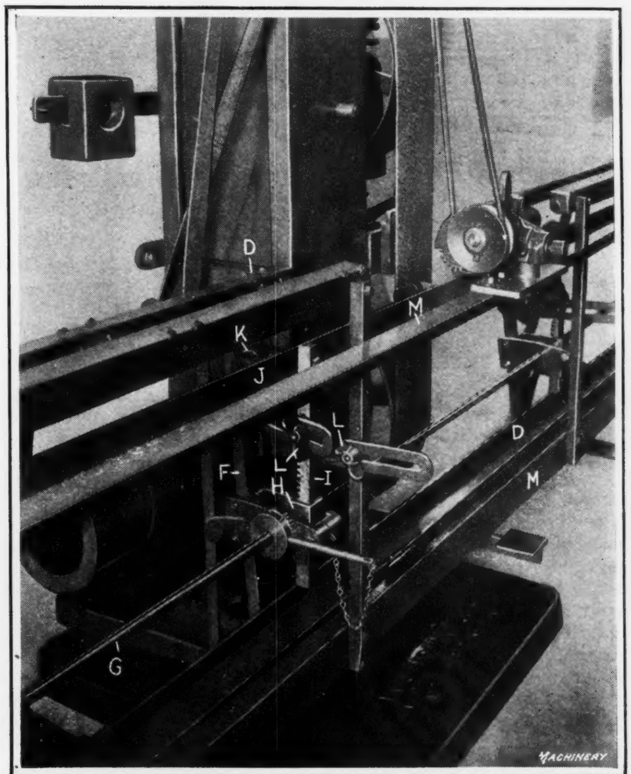


Fig. 4. Close-up Rear View of Blevney Polishing Machine

The platen *N* which presses the belt against the tube has been altered from previous designs, so that it may be removed for adjustment and its form changed without stopping the machine. This is an important improvement. It should also be mentioned that the machine is built largely upon the unit plan, so that the various brackets, shafts, and fixtures are interchangeable with other designs of polishing machines requiring somewhat different treatment in the details.

The capacity of the machine for polishing tubing is quite remarkable, the rapidity as compared with hand methods being several times greater. This same machine can be furnished without the tube fixture, but with a short table and

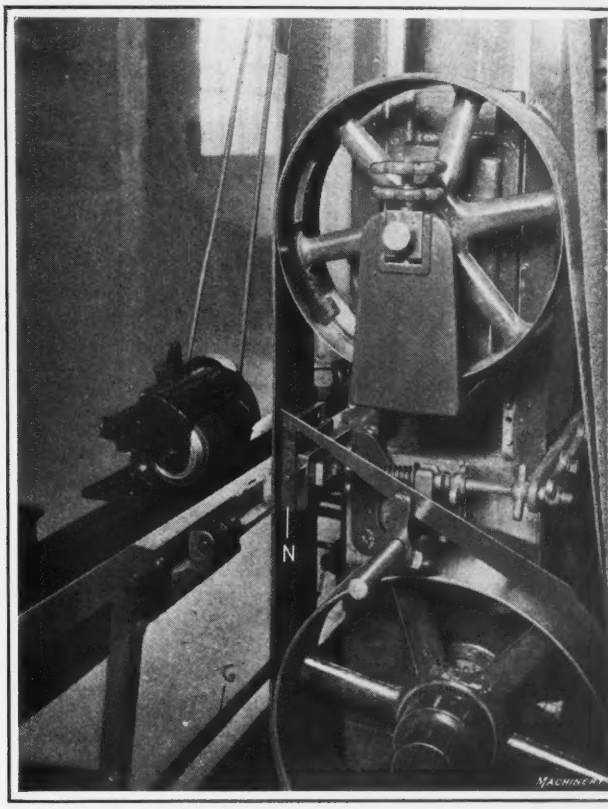


Fig. 5. Provision made for pressing Belt against Tube

with or without the power feed-roll, for performing a great variety of polishing and finishing operations on metal, rubber, fiber, etc.

NEW MACHINERY AND TOOLS NOTES

Universal Toolpost: Watts-Myers Tool Co., Los Angeles, Cal. This is a heavy-duty toolpost for handling forged steel cutting tools of the type used in lathes, planers, etc. It is designed for holding tools ranging from 3/4 by 3/4 inch up to 1 by 1 3/4 inch in size, although holders with various forms and sizes of inserted cutters can also be accommodated by this toolpost.

Power Hand Plane: Universal Planer Co., Inc., Room 6, 16 Exchange Place, New York City. This is a motor-driven hand plane which is intended primarily as a substitute for the jack plane in planing the sides of wooden ships. In addition to this work, the plane is equally applicable in finishing any wooden surfaces where an ordinary hand plane could be employed.

Gun-boring Lathe: Riter-Conley Co., Pittsburg, Pa. A machine known as the "Ricon" gun-boring lathe, which is especially designed for drilling gun barrels from the solid blanks, although this lathe can also be used for finish-boring operations, if so desired. When used for finishing, the boring-bar does not revolve as in the case where the machine is employed for drilling the barrel from the solid blank.

Industrial Truck: Baker R. & L. Co., Cleveland, Ohio. These trucks are designed for use in handling unwieldy prod-

ucts of industrial plants, which cannot be economically trucked by hand or transported by overhead traveling cranes. The trucks are furnished with a storage battery outfit for driving, and with a crane hoist by which the load is lifted and held while being carried to the desired destination.

Riveting and Punching Machine: Hanna Engineering Works, 1765 Elston Ave., Chicago, Ill. This is a special type of machine designed for use in the performance of riveting and punching operations in shipyards. In addition to driving rivets 1 inch in diameter with a single stroke of the piston, the machine can also drive a punch which will cut holes of the same diameter in material up to 5/8 inch in thickness.

Extension Reel for Electric Lamps: Cincinnati Specialty Mfg. Co., Inc., corner Powers St. and Sylvan Ave., Cincinnati, Ohio. An automatic extension reel for electric lamps, which is self-winding, so that the lamp cord can be wound up in a similar manner to that employed in operating an ordinary window shade roller. The reel is 9 inches in diameter by 2 inches wide, and has a capacity for carrying 25 feet of cord.

Gun and Propeller Shaft Lathe: Pittsburg Machine Tool Co., Braddock, Pa. A lathe with a swing of 50 inches, which is especially adapted for use in machining propeller shafts and for handling the work of gun shops. It may be equipped with either belt or individual motor drive and supplied with any length of bed to meet the requirements of the work. A quick traverse mechanism is furnished to save time in reversing the carriage.

Shell Lathes: R. M. Eddy Foundry Co., Chicago, Ill. This company has recently placed on the market a line of shell finishing lathes which are sold under the trade name of "Bryant." They are of the single-purpose type and of quite similar design, with the exception of the carriage, which is arranged on each machine to adapt it for the specific operation that is to be performed. It is claimed for these machines that they are rigidly constructed, simple, and convenient to operate.

Bridge Reamer: Advance Machinery Co., Van Wert, Ohio. This reamer is made with high-speed steel blades and a machine steel shank, the blade portion being threaded on a slight taper so that it will automatically tighten in the shank. The blade portion and shank may be separated at any time, making it unnecessary to buy a new shank when the blade is worn out. Reamers of this type are made in four sizes, having capacities for reaming holes 11/16, 13/16, 15/16, and 1 1/16 inch in diameter.

Milling and Dividing Head for Lathes: Eccles & Smith Co., 71 First St., San Francisco, Cal. This consists of a dividing head and milling attachment for use on the lathe, which is provided with an overhead drive. Means are furnished for securing power longitudinal and cross feed for the dead spindle. This company is also building a grinding and spacing attachment for use on lathes, which is arranged with overhead drive. For handling dividing work, the piece may be held either between centers or in the chuck.

Spring-head Tool-holder: Cleveland National Machine Co., 1366 W. 70th St., Cleveland, Ohio. A tool of the spring-head or so-called "gooseneck" type, which is adapted for use in performing such operations as forming, threading, grooving, cutting off, etc. Tool-holders of this type are provided with three tool clamps which take regular stock in flats 1/8 by 7/16 inch in size; rounds, 3/16 to 5/16 inch in diameter; and squares, up to 5/16 inch. Provision is made for adjusting the tool right or left to any angle up to 90 degrees.

Corrugating and Curving Machines: Streine Tool & Mfg. Co., New Bremen, Ohio. One of these machines is intended for use in corrugating steel used in constructing shelters for the United States Army. The material is 11 gage, and the corrugations are 4 inches deep by 12¾ inches center to center, the top and bottom of the corrugations being 5¾ inches wide. After the sheets have been corrugated in this way, they are curved to a 5-foot radius, and it is for the performance of this curving operation that the second machine is employed.

Motor-driven Air Compressor: Ingersoll-Rand Co., 11 Broadway, New York City. A portable air compressor which saves labor through enabling the machine to be taken to any point where it is required. In this way, provision can easily be made for using air-operated tools which are the means of saving a substantial amount of labor in the performance of drilling, riveting, chipping, calking, and similar operations. This air compressor is driven by a 50-horsepower Westinghouse motor and has a capacity of 300 cubic feet of air per minute at a pressure of 100 pounds per square inch.

Gas-fired Furnace: Johnson Gas Appliance Co., Cedar Rapids, Iowa. A No. 650 gas furnace which is adapted for use in heat-treating, tempering, casehardening, or annealing pieces made of carbon tool steel that come within its capacity. It is claimed that such operations can be performed without danger of decarburizing the work or of causing damage through oxidation. The furnace is equipped with six burners, and no air blast is required to produce a temperature of 1800 degrees F. The firebox measures 13½ by 8 by 5 inches in size, and the gas consumption is from 75 to 85 cubic feet per hour.

Index Centers: C. F. Kern, Hulbert Block, Cincinnati, Ohio. Mr. Kern has recently placed on the market what is known as the "Schipper" universal index center, which is designed in such a way that the head can be set to any angle from 10 degrees below the horizontal to 10 degrees beyond the vertical position, and it can also be rotated on the base to any required position. These features are said to make this index center particularly useful for employment in cutting bevel gears on a plain milling machine, for gashing worm-wheels, milling counterbores, and for the performance of similar operations.

Flange Facing Machine: Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. This machine is adapted for use in truing up the face of brass flanges after they have been attached to irregularly shaped copper high-pressure steam pipes. Motor drive is provided, with the motor mounted at the rear of the bed; and the spindle is driven by a bronze worm-wheel and a hardened steel worm, fitted with hardened steel bearings, the drive being enclosed to provide for a flooded lubrication. A bale is furnished near the center of the bed by means of which the machine can be picked up by a crane and moved to any required position.

Power-operated Pyrometer: Leeds & Northrup Co., Philadelphia, Pa. This company is now making a line of power-driven instruments for use in measuring and controlling temperatures. They are of the potentiometer type, in which the adjustments are automatically effected and the galvanometer merely determines the direction in which adjustment is to be made. The pointer serves as a mechanical trigger, and a reciprocating part, which is kept in constant motion by an electric motor, is so arranged that it does not strike the pointer when in the middle or "no current" position. When the pointer moves in either direction, the reciprocating part pushes it against a third member, which, in turn, adjusts the potentiometer circuit, the amount of adjustment being regulated according to the distance that the pointer is swung from the middle position, this being proportional to the amount of unbalancing current which is passing through the galvanometer. The motor also operates a recording chart.

Electric Arc Welding and Cutting Apparatus: Electric Arc Cutting & Welding Co., 222 Halsey St., Newark, N. J. This company has recently developed a special apparatus designed in such a way that it enables alternating current to be employed for the performance of cutting or welding operations. Alternating current of any of the usual primary voltages can be employed as well as any of the standard types of transmission systems. The apparatus is portable, so that it may be taken directly to the point at which the work is to be done. Equipments of this kind are built in three different types adapted for the performance of cutting, welding and cutting, or welding operations. They consist of a special transformer with no moving parts and a shunt in the magnetic circuit to make it possible for the operator to regulate conditions according to the temperature which is required for handling the particular work on which he is engaged. The weight of this complete outfit with all auxiliaries is about 200 pounds, so that two men can easily set it up in any desired location. This adds greatly to the convenience of the apparatus, because it is often advisable to perform cutting or welding operations where the work is located in the shop, instead of having to take the work to the machine.

* * *

CONSERVATION IN DROP-FORGED WRENCH MANUFACTURE

At a recent meeting, in Buffalo, of manufacturers of drop-forged wrenches it was agreed to reduce the number of sizes, styles, and methods of finishing their products for the purpose of furthering the Government's conservation policy during the period of the war. The following is a list of wrenches the manufacture of which it was agreed to discontinue: All so-called heavy cap-screw wrenches, 22½-angle or textile machine wrenches, including all millings from this line of blanks, concave "S" wrenches, machine wrenches, long flat-handle wrenches, and double-head socket wrenches. The types of wrenches retained as necessary are: Engineers' wrenches, check-nut wrenches, light cap-screw wrenches, hexagon box wrenches, square box wrenches, flat-handle "S" wrenches, set-screw wrenches, toolpost wrenches, single-head socket wrenches, spanner wrenches, construction wrenches, round-handle track wrenches, car wrenches, and light-weight wrenches, which are of such importance as to make their elimination a loss rather than a gain. The makers have also arranged to discontinue immediately the manufacture of all regular finished wrenches which will eliminate a great deal of labor required in polishing and lacquering. The elimination of the semi-finished wrench was also considered, and a "war-finished" wrench may be ultimately substituted which will be equally efficient, although slightly different in appearance. Until the present stock is exhausted, all orders for regular finished wrenches or any of the types mentioned will be filled as specified. Thereafter semi-finished wrenches will be supplied.

A NEW BOOK ON SHOP MANAGEMENT

SHOP MANAGEMENT AND SYSTEMS. By Franklin D. Jones and Edward K. Hammond. 307 pages, 6 by 9 inches; 158 illustrations. Published by The Industrial Press, 140-148 Lafayette St., New York City. Price, $2.50.

This book is a treatise on the organization of machine building plants and the systematic methods that are essential to their efficient administration. It has been prepared with a view to giving definite information on various systems in use for insuring orderly and effective methods of procedure in the management of manufacturing, designing, and purchasing departments. Practically the entire volume is filled with specific examples showing the exact details of different systems actually in use in prominent machine-building plants, indicating how these systems may be applied under various conditions. This, in fact, is one of the strongest features of the book, because the concrete examples given will mean a great deal more to the practical man than would general and abstract theories of management. As the systems are applicable to the specific plants in which they are used, they may not, of course, be directly applied to all other industrial organizations without modification, but they form a definite basis upon which to work, and will enable the user of the book to see more clearly the relation between the system and the branch of work to which it is applied. The treatise is intended for works managers, shop superintendents, and executives of all classes in industrial plants, as well as for those who aspire to fill executive positions. The fact that modern equipment in machine shops and other manufacturing plants cannot be efficiently used without systematic methods of management is generally recognized, and it is believed that those interested in efficient engineering and manufacturing methods in the shop, drafting-room, or college will find helpful information in this book.

In order to give a general idea of the contents of the book, the headings of the fifteen chapters into which it is divided follow: Industrial Organization and Management; General Shop Systems; General Tool and Supply System for Large Plants; Ordering, Manufacturing, Distributing, and Accounting System for Special Tools; Following Progress of Work in Manufacturing Department; Inspection System for Machine Shops; Storage and Maintenance of Small Tools; Tool Checking Systems; Methods of Delivering and Identifying Tools; Tool Supply System under Scientific Management; Tool Engineering Department; Organization of an Assembling Department; System of Purchasing Department; Wage Systems; and Drafting-room Systems. In practically all instances the forms and blanks used with the different systems for recording useful data are included to show the exact methods of procedure.

* * *

WAXING STEEL SURFACES PREPARATORY TO ETCHING

The writer has noticed that it is customary in most places to use a heated piece of drill rod or similar stock when applying wax to hardened steel surfaces preparatory to etching. This method does not give a wax coating of uniform thickness, and often fails to cover the entire surface exposed to the acid. This frequently results in unsightly stains on hardened surfaces that have been ground and lapped. To prevent this, the writer would suggest that a suitable receptacle be provided in which the wax can be heated to the required temperature. The surface to be heated can then be dipped in the melted wax, or if desired, the entire piece can be immersed. In this way, a uniform coating of wax can be given to the work, and the danger of acid stains will be eliminated. J. D.

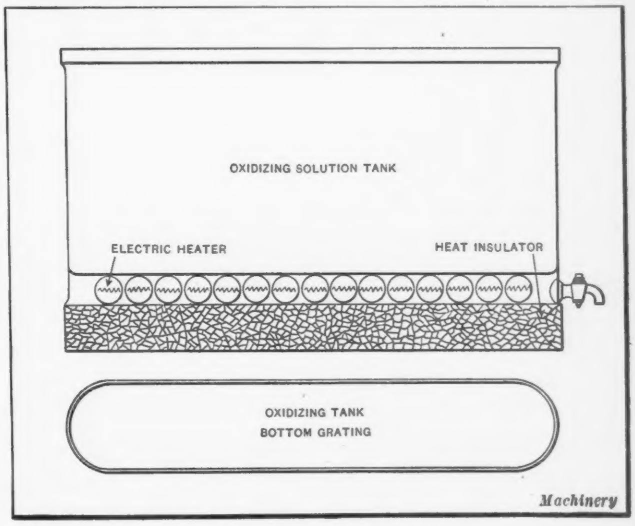
* * *

The Interstate Motor Trucking Transportation Association, Inc., was formed at the Hotel Imperial, New York City, on August 13 to further develop and extend the new motor truck transportation business by long distance regular freight and express routes. The plans of this organization may to a great extent change the whole problem of freight and express transportation in this country. Ramon V. Williams, 24 Stone St., New York City, is president.

GUERINI PROCESS FOR THE OXIDATION OF FINISHED METAL SURFACES

A new process for blackening or oxidizing smooth iron and steel surfaces which is based on the oxidizing action of picrates has been developed by Dr. B. Guerini, of Brescia, Italy. This process gives the objects to be oxidized, whatever may be their shape, a uniform and durable coat of oxide which cannot be affected either by ammonia or by a solution of sulphate of copper. This coating is intimately imbedded in the iron, as the oxidation is obtained at the expense of the iron itself. With this method, the range of shades from the dead black to the most shiny black can be obtained. One of the advantages claimed for this process is that it requires only a few simple operations, which can be performed in an hour's time.

The oxidation is effected in a bath in which the work is immersed for about fifty minutes. The bath has to be brought up to the boiling point, which varies in temperature, according to the strength of the solution, from 250 to 290 degrees F. The oxidation takes place in a few minutes, but the object must be kept in the bath and maintained at the boiling temperature for about fifty minutes in order to allow the oxide layer to set deeply and become permanently fixed. Afterward the oxidized objects are passed through a tank containing hot water, and from there to a tank containing a mixture of oil and kerosene. They are then removed and dried in sawdust.



Oxidizing Tank used in Gun Factory

An Italian factory, turning out six hundred rifles a day, uses three electrically heated tanks, as shown in the accompanying illustration. These tanks measure 38 inches in length, 10 inches in width, and 36 inches in depth. Each tank has a capacity for twenty-five gun barrels. Four workmen are sufficient to handle the entire daily production of six hundred rifles. Each tank contains about one hundred and fifty pounds of a solution composed of water, sodium hydrate, and picric acid. This solution can be used over and over again for at least forty times, thus making it possible to oxidize about eight hundred gun barrels with one hundred and fifty pounds of the solution. The smaller metal parts of the rifle can be oxidized in a very short time, as a large quantity of them can be placed in each tank at a time.

The Guerini process is already used by a large number of Italian manufacturers engaged in the production of rifles, machine guns, pistols, bayonets, motorcycles, etc. Carlo Bertolaia, 309 Broadway, New York City, who represents the inventor in this country for the sale of the United States patent, states that exhaustive tests of the Guerini process have been recently made at one of the largest firearm factories in this country and that the results obtained were very satisfactory.

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MACHINERY'S ANNUAL INDEX

The yearly index to the twenty-fourth volume of MACHINERY for September, 1917, to August, 1918, inclusive, is now ready for distribution. Copies will be sent upon request.

MOUNTING CROSS-LINES IN OPTICAL INSTRUMENTS

BY J. A. WIDMER[1]

While there is a tendency in the design of modern optical instruments to replace the time-honored spider cocoon cross-lines by the more stable plano-parallel glass plate with etched or diamond-cut lines, there is nevertheless a large proportion of instruments where the spider thread is the only satisfactory means of fixing the line of collimation. The glass plate with its etched or cut lines is less liable to breakage than the more delicate spider thread, but the loss of light caused by the former, often aggravated by a film of condensation of moisture or a collection of minute dust particles on the glass plate, is a distinct disadvantage. Furthermore the cutting on glass of clean sharp lines, fine enough to be suitable for use with high-power eye-pieces, is very difficult and the lines frequently show color fringes while the spider cocoon thread stands out deep black and clearly defined against the field of view and, by appropriate selection, can be made to suit any type or power of eye-piece.

Two Methods Used in Mounting Cross-lines

There are many ways of mounting these delicate threads on their respective metal reticules, but the following describes

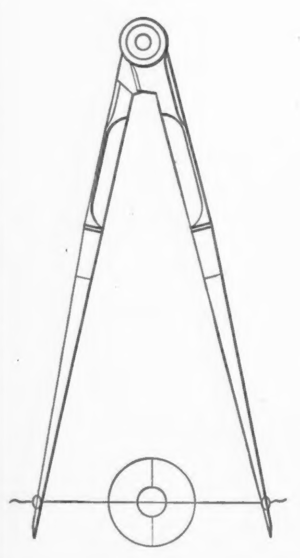

Fig. 1. Using Dividers in mounting Cross-lines

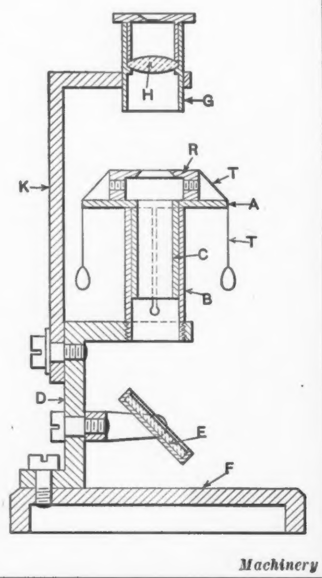

Fig. 2. Sectional View of Fixture for mounting Cross-lines

only two. The first is a mere makeshift method but is nevertheless satisfactory in many cases or in an emergency, while the second describes an excellent way of obtaining good clean cross-lines that will stand the severe test of a surveying instrument used in the field. The preparation of the reticule is in both cases the same and consists in cutting lines where the cross-hairs are to be placed with a very fine sharp steel point or a dividing tool. This may be done by means of a dividing head and surface gage or with a special fixture made for the purpose. The bright lines in the previously blackened reticule show clearly and form a groove in which subsequently to lay the cross-hairs. There are several kinds of spiders that produce suitable threads, and their cocoons or nests may be found in the cracks and crevices in the bark of old trees, under cornices and head jambs of houses and in other protected places. The cocoons should be gathered before the eggs hatch out; otherwise the young spiders, in eating their way out, will cut the whole nest into short fragments unsuitable for the purpose in view. The cocoon should be pulled apart so that the eggs may be removed.

The first method is to place an ordinary divider partly opened on a sheet of dull black paper and fasten a little lump of beeswax on each leg near the end. Draw out a few threads from the spider cocoon with the fingers or a pair of tweezers and select a thread that is even and of uniform thickness; lay it across the divider points on the lumps of wax and fasten it to the latter by either touching the wax with a hot metal rod or by pressing additional lumps of wax on top of the first ones. Now cut off the ends of the thread and carefully open the divider so as to stretch the thread tight. Lay the reticule on the sheet of paper and place the divider with the thread over the reticule so that the thread falls in the grooves on the latter, as shown in Fig. 1. Put a little drop of thick liquid shellac over the thread on each side of the reticule near the inside edge and let it stand until dry. Cut off the outside ends of the thread, and one cross-line is finished; the other is finished in the same way.

Mounting Fixture

The second method is used to produce first-class cross-lines that will stay tight in all kinds of weather and climates, and is a little more elaborate than that just described. The special mounting fixture that is used is shown about one-half actual size in the sectional view, Fig. 2. It is preferably made entirely of brass with the exception of the optical parts. The table *A*, carrying the reticule *R*, is fastened to the tube *C*, which revolves, together with the table, in the slotted tube *B*. The latter is screwed into the bracket *D*, which, in turn, is fastened to the base *F*. The bracket also carries an arm with an adjustable mounting for the mirror *E* and the reading lens arm *K*. The latter is held in position by a screw and a spring washer, and can be swung forward or backward out of the way. The reading lens *H* is held in tube *G*, which is threaded on the outside so that it can be screwed up or down for focussing the lens. The latter is an ordinary biconvex reading lens of about 1½ inch focal distance.

Preparation of Threads

The preparation of the threads is accomplished as follows: Draw out a thread from the cocoon as previously described; select one of suitable length and fasten a little lump of wax to each end. This is best done by rolling out a lump of wax between the fingers into cylindrical pieces of about 1/16 inch diameter and about 3/4 inch long, and then bending them in the middle into a U-shape. Place one of these wax pieces over each end of the spider thread and press them together with the fingers so as to clamp the thread between the two shanks of the U; then roll them into ball shape. Now pick up one of the balls and raise it carefully so that the other one is lifted up and hangs on the spider thread, keeping the latter stretched tight. Wash the thread with a fine camel's hair brush dipped in water, passing the brush with great care over the whole length of the thread. This process will stretch the thread considerably. Now dip the brush in grain alcohol, repeat the washing, and hang the thread up to dry for a few minutes by fastening the upper wax ball to a rack or stand and letting the lower end hang down.

The thread is mounted by laying it across the reticule *R* so that one wax ball hangs down on each side of the table *A*, keeping the thread *T* stretched tight. Now, looking through the magnifier *H* and reflecting the light from a nearby window or other source upward through the opening in the reticule by means of the mirror *E*, make sure that the thread lies exactly in the previously cut groove or line on the reticule, shifting it, if necessary, with a small wire hook, until it occupies the correct position. Turn the table around about a quarter turn, place the second thread in the same fashion, and fasten both threads near the inside and outside edges of the reticule with a little thick liquid shellac or other spirit lacquer. When completely dry, cut off the ends with a pair of scissors; the reticule is then ready to be inserted in the telescope.

* * *

The Machine Tool Section of the War Industries Board calls attention to the notice issued by the Railroad Administration stating that between now and cold weather, with its inevitable effect upon the movement of freight, the greatest possible tonnage should be moved; the utmost expedition should be insisted upon in the unloading of cars, and everything possible done to avoid a repetition of the vicissitudes of last winter.

[1]Address: 531-A Washington Ave., Brooklyn, N. Y.

MANUFACTURE OF MANGANESE STEEL CASTINGS[1]

BY BRADLEY SAYRE CARR[2]

Manganese steel has long been a familiar term, yet it is doubtful whether full consideration has been given to the development of this material and its application to machinery. As this steel has remarkable resistance to abrasive wear, extreme toughness and hardness, combined with ability to absorb severe shocks and impacts, it is used extensively for parts of machinery that are subjected to extreme wear and abrasion where durability is of prime importance. Manganese castings are used for a great variety of purposes including parts for steam shovels, crushers, dredges, grab buckets, rolling-mill machinery, copper converters, mills, cement kilns, asphalt presses, brick and tile machinery, coal mining and breaking machinery, concrete mixers, traveling cranes, lifting magnets, and gears. Manganese steel is also used for the manufacture of safes, railway frogs and crossings, foundry tumbling barrels, and many other things of like nature.

Physical Characteristics

Manganese steel is similar in analysis to ordinary converter metal, except that it generally contains from 1 to 1.3 per cent carbon and from 11 to 13.5 per cent manganese. As the casting comes from the sand, it is almost glass hard and brittle and must be made ductile by heat-treatment. The necessity for heat-treatment limits the thickness of section it is possible to use successfully. Originally, the castings were made with comparatively thin sections and could not weigh more than a few hundred pounds; at present, however, castings, with walls up to 5½ inches thick and weighing 30,000 pounds and more are handled satisfactorily. In fact, it does not appear that the limit of weight has yet been reached by a considerable margin. Heavy castings are cored to a minimum thickness of 5½ inches so as to eliminate internal stresses, invariably set up in a very thick casting, and also to reduce the weight and inertia of the piece. At the same time the maximum allowable heat-treating thickness of 5½ inches is sufficient to permit the use of manganese steel for the heaviest classes of machinery.

The tensile strength of manganese steel is from 90,000 to 110,000 pounds per square inch. The elastic limit is about 50,000 pounds per square inch. The elongation, in 2 inches, is about 33 per cent; the reduction of area is about 35 per cent. The specific heat ranges from 0.145 at ordinary temperatures to about 0.2 at 1200 degrees C. Between ordinary atmospheric temperatures and 600 degrees C., the heat conductivity appears to be about one-third that of the low-carbon steel. The electrical resistance is approximately 3.4 times the resistance of ordinary Bessemer steel and between 100 and 600 degrees C., the resistance is said to remain practically constant. Because manganese steel is non-magnetic, it is used for the shields or bottom plates of lifting magnets. The shrinkage is high, amounting to 5/16 inch per foot, as against 3/16 to ¼ inch in ordinary steel foundry practice.

Manganese steel does not owe its wear resisting qualities to its hardness. When subjected to the Brinell test it shows an average hardness of about 200. The extreme outer fiber of the treated steel shows a slightly lower hardness number than the steel about ⅛ inch below the surface; from the latter point the hardness remains constant to the core of the casting. This reduction of hardness at the surface is due to the oxidation of the carbon that forms on the surface during the heat-treatment. The toughness of the material is due to its great molecular cohesion, which causes the particles to flow rather than to tear off. When tested with a scleroscope, manganese steel shows a hardness of from 40 to 50.

Heat-treatment of Manganese Steel Castings

Manganese steel of ordinary composition poured in a layer about ¼ to ½ inch thick in a chill mold, when cold, will bend double and has all the usual toughness of reheated and quenched manganese steel; if cast in a sand mold, the toughness approximates that of the reheated and quenched metal inversely as the thickness of the sand-cast section. For example, a sand-cast section ½ inch thick will usually bend from 45 to 90 degrees before it breaks by cold bending; a section 2 inches thick will break before it is deflected 20 degrees. The thinner section is whiter and has smaller crystals that the heavier, but the crystals of the chill-cast section are still whiter and smaller. If the chill-mold casting and the two sand-mold castings are heated to 1000 degrees C. and quenched with water, they will have practically an equal degree of toughness and hardness. If they are then heated to 700 degrees C., or a little lower, and held at this temperature for one-half hour and afterward cooled slowly to ordinary temperature and broken, they are weak and bend but slightly before breaking. A section 3 inches thick cooled slowly from the heat of casting and put under a drop weight will break about as readily as an equal thickness of a fair quality of gray iron and will frequently show crystals with a mirrored surface as large as ¼ or 1 inch. Specimens heated to above 700 degrees C. and cooled slowly to below 600 degrees C. are very weak; if reheated to 700 degrees C. and quenched in water, only a slight increase in toughness will be noted. Manganese steel that has been weakened by slow cooling from 700 degrees or above is only put in a condition of maximum toughness by reheating to a much higher temperature and then cooling rapidly enough to prevent mechanical or chemical separation.

Manganese steel is readily burnt when heated, and this tendency to burn increases as the temperature is raised. For this reason it is usual to heat for quenching only to a point sufficiently high to give the characteristic toughness in the quenched metal.

In operating the annealing ovens or furnaces, it is necessary to heat the castings slowly so as not to create expansion stresses, which will cause cracks. After the proper temperature is reached—from 1600 to 2200 degrees F.—the castings must be given a soaking heat for several hours in order to bring the molecules into a state of equilibrium. The time required for this operation varies from four to twenty-four hours, depending on the size and character of the casting. The water in the quenching tanks should be as cold as possible so as to cool the castings quickly before there is time for any internal structural changes. The men drawing the castings from the annealing furnaces must be protected from the heat with special clothing and helmets. Respirators also are desirable, owing to the noxious gases emitted from the furnace when the door is opened.

Cleaning and Machining Manganese Steel Castings

The proper cleaning of manganese steel castings presents many problems. Very little sand adheres after the casting comes from the quenching bath, but the metal is so tough that practically all the trimming must be done by grinding. Extensive, portable, electrically driven grinding equipment is necessary for this purpose.

When castings are to be finished in any way, ordinary machining methods are unsuccessful and grinding must be resorted to, necessitating special equipment. Holes more than 1¼ inch in diameter are cored out of the castings and ground to size with special wheels. When it is necessary to drill smaller holes or to cut threads, soft steel or wrought-iron inserts are set in the molds at the desired points, like chaplets, and the metal is cast around them. Incidentally, this adds to the difficulties of the foundryman. Sometimes bushings are set in the hubs of gear wheels when it is desired to machine them by ordinary methods. Liberal allowances of metal are made for grinding in order to minimize the danger of spoiling the work in the machine shop. It is necessary for the machine shop foreman to exercise his judgment continually; coarse wheels and heavy cuts are used so that the metal is removed rapidly, although by no means as easily as would be the case were it possible to employ ordinary cutting tools.

* * *

Oil stains on concrete floors may be removed by covering with a mixture of 1 pound of oxalic acid, 3 gallons of water and enough wheat flour to make a paste that can be applied with a brush. The paste is removed with clean water.

[1] Abstract of an article published in the "Armour Engineer."

[2] Sales and mechanical engineer of the American Manganese Steel Co., Chicago, Ill.

OBITUARIES

WILLIAM KENT

William Kent, of Montclair, N. J., formerly dean of the L. C. Smith College of Applied Sciences, Syracuse University, died in Gananoque, Ontario, Canada, September 18, aged sixty-seven years. He was one of the most well-known men in the mechanical engineering field, and was unusually well informed upon many of the various phases of engineering. He was especially an expert on the properties of iron and steel as applied to structural purposes.

Professor Kent was born in Philadelphia, March 5, 1851. He was educated in the public schools and graduated from the Central High School, in Philadelphia, in 1868. He was then employed as clerk and bookkeeper in a coal shipping house for nearly two years. After leaving this position he was bookkeeper in the Jersey City Gas Office for two and a half years. Meanwhile, he attended night school at Cooper Union, New York City, and graduated with the class of 1872. After graduation, he obtained a position as bookkeeper in the Ringwood Iron Works, at Hewitt, N. J., where he had an opportunity to obtain some experience in engineering and chemistry. The depression in the iron trade following the panic of 1873 caused the shutting down of the blast furnace, and he left at the end of 1874 to enter Stevens Institute of Technology as a special student. In June, 1875, he was appointed assistant to Professor R. H. Thurston in the work of the United States Iron and Steel Testing Board, and under his direction carried on for two years a research on the properties of the alloys of copper and tin, and copper and zinc. He also qualified as a regular student in the senior class, and graduated in 1876 with the degree of M.E.

In 1877, he went to Pittsburg as a draftsman with a firm of blast furnace engineers. While engaged in this work, he made a trip through the new iron district in the Hocking Valley, Ohio, and wrote an account for the district for the *American Manufacturer*, of Pittsburg. This led to his appointment as editor of that paper, which position he held for two years. In the next three years, he was engaged in the iron and steel works of Shoenberger & Co., first as general assistant and later as superintendent of the open-hearth steel department. Some time later, he opened an office in Pittsburg for the Babcock & Wilcox Co., and introduced that company's boilers in western Pennsylvania and eastern Ohio. He also formed a partnership with William F. Zimmerman in the organization of the Pittsburg Testing Laboratory, which was sold later to Hunt & Clapp. In 1883, he came to the New York office of the Babcock & Wilcox Co. as superintendent of the sales department and engineer of tests; he resigned from this position in 1885 to become general manager of the Springer Torsion Balance Co. Here he developed the invention of the weighing scale with torsional pivots instead of knife-edges, used generally in the retail drug trade, and he also built and equipped a factory in Jersey City for the manufacture of this scale. He was engaged in this work until 1890, when he opened an office in New York as consulting engineer. For the next thirteen years, his work was of a varied nature, including engineering design and construction, engine and boiler testing, and literary engineering work.

Professor Kent is best known to the mechanical world as the author of "Kent's Mechanical Engineer's Pocketbook," which, for many years, was the standard engineering handbook in the United States. He began his work on this book in 1891 and spent four years on its completion. The book was published in 1895 and immediately was recognized as filling a long-felt want among engineers, draftsmen, and others having to do with mechanical work and design. In 1895, he also became one of the associate editors of *Engineering News*, which position he held until 1903, at which time he became dean and professor of mechanical engineering in the L. C. Smith College of Applied Sciences, at Syracuse University, Syracuse, N. Y., which position he held for several years. In 1905, the university conferred upon him the degree of Doctor of Science. In addition to his handbook, he brought out a treatise on "Steam Boiler Economy," in 1901, and shortly before his death, he published a large work entitled "Bookkeeping and Cost Accounting for Factories." He is also the author of a work known as "Investigating an Industry." Numerous patents were obtained by Professor Kent during his varied engineering activities. In 1898 and 1901, he obtained patents on the Wingwall smokeless furnace for steam boilers, and, in 1903, he patented a gas producer for use in connection with gas engines.

Professor Kent was a member of many engineering societies. He had been a member of the American Institute of Mining Engineers since 1876, and of the American Society of Mechanical Engineers since its organization in 1880. He was vice-president of this latter society and, in 1905, was president of the American Society of Heating and Ventilating Engineers.

PERSONALS

Alof Stromberg has been appointed general foreman of John Bath & Co., Inc., Worcester, Mass.

Walter Gray has been appointed superintendent of John Bath & Co., Inc., Worcester, Mass.

Harry F. Clifford, for the past two years superintendent of John Bath & Co., Inc., Worcester, Mass., has been appointed works manager of the company.

E. R. Wood, formerly eastern representative of the High-Speed Hammer Co., Rochester, N. Y., has become associated with the Sherritt & Stoer Co., Philadelphia, Pa., in its Sales Department.

A. J. Barnes has been appointed export manager of the Shepard Electric Crane & Hoist Co., with headquarters in Montour Falls, N. Y. Mr. Barnes will also continue his work as director of publicity for the company.

F. W. Shumard, formerly equipment and production engineer at the Utica plant of the Savage Arms Corporation, is now employed in the Maintenance Division of the Motor Transport Corps, Washington, D. C., in a similar capacity.

C. W. Cross has been appointed special representative of the Chicago Pneumatic Tool Co., Chicago, Ill., for the sale of pneumatic tools to railroads, in place of L. C. Sprague who has been promoted to the position of district manager of sales for the company at New York.

Harry L. Barnitz, who was formerly a sales agent for the International Oxygen Co., has entered into business for himself as a consulting engineer on oxygen and hydrogen, plant instillation, and technical processes for their uses, with an office at 617 W. 152nd St., New York City.

Charles Lea, formerly chief engineer of West & Dodge, Boston, Mass., has opened offices at 161 Summer St., Boston, where he will conduct a general consulting engineering business under the name of the Lea Engineering Co. Special attention will be paid to the design of machinery for testing thread leads.

R. W. Davis is now connected with the sales organization of the Cleveland Milling Machine Co., Cleveland, Ohio, and is in charge of the Detroit territory, with offices at 705 Dime Bank Bldg., where a large quantity of standard milling cutters are carried in stock. Mr. Davis has had extensive experience in this line.

Leonard W. Egan, formerly special engineer with the Wellman-Seaver-Morgan Co., has become associated with the Electric Furnace Co., Alliance, Ohio, in a similar capacity. Previous to Mr. Egan's connection with the Wellman-Seaver-Morgan Co., he was for five years electrical engineer with the Pittsburg Crucible Steel Co., Midland, Pa.

Roger P. Redier has been appointed general sales manager for the Allied Machinery Co. of America, 120 Broadway, New York City, with headquarters in Paris, France. Mr. Redier has had long experience in selling American machinery throughout continental Europe. He is now in the United States visiting the factories, and expects to return to France this fall.

H. E. Henry has been appointed general sales manager of the Fulflo Pump Co., Blanchester, Ohio, succeeding A. N. Martin, who is now associated with the Pyle National Co. of Chicago, Ill. Mr. Henry has been connected with the Fulflo Pump Co. in the capacity of purchasing agent ever since the business was established. He will also continue to act as purchasing agent for the present.

A. E. Brion, president of Peter A. Frasse & Co., Inc., 417 Canal St., New York City, recently celebrated the completion of forty years of service with the company by entertaining the directors and members of the advisory board, as well as a number of business men in allied industries, at a dinner at the Columbia Yacht Club. Before the dinner, the employes presented Mr. Brion with a gold watch and chain as an expression of the high esteem in which he is held. In further celebration of the anniversary, Mr. Brion gave a reception and dance for the employes of the company.

COMING EVENTS

October 7-12—Joint convention of the American Foundrymen's Association and the American Institute of Metals in Milwaukee, Wis. Concurrent with these meetings there will be an exhibition of foundry equipment, machine tools, and accessories.

October 25-26—Section meeting of the American Society of Mechanical Engineers in Indianapolis, Ind.

November 7-8—Annual convention of the National Machine Tool Builders' Association in New York City, with headquarters at the Hotel Astor. General manager, Charles E. Hildreth, Worcester, Mass.

December 3-6—Annual meeting of the American Society of Mechanical Engineers at 29 W. 39th St., New York City.

SOCIETIES, SCHOOLS AND COLLEGES

University of Utah, Salt Lake City, Utah. General catalogue for 1918-1919, containing announcements of courses and list of students.

Polytechnic Institute of Brooklyn, College of Engineering, 85 Livingston St., Brooklyn, N. Y. Catalogue of evening technical courses in engineering, chemistry, mathematics, languages, history, and economics for 1918-1919.

NEW BOOKS AND PAMPHLETS

Manual of Engineering Drawing. By Thomas E. French. 329 pages, 6 by 9 inches; 556 illustrations. Published by McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City. Price, $2.50.

This is the second revised and enlarged edition of Professor French's book on engineering drawing for students and draftsmen. The author, as professor of engineering drawing at the Ohio State University, has had an unusual opportunity to determine the character of instruction that is especially needed by the student. As the earlier edition of the book has been used by over 200 technical schools, it has been possible to obtain a certain amount of constructive criticism, and numerous changes and additions that have been thought desirable have been made. The important changes and additions in the new book are: A new chapter on lettering of twenty-two pages and forty-five illustrations, designed to give a thorough course for engineers, with detailed analysis of the letter forms and discussions of composition of letters and words, with a carefully graded series of exercises; a separate chapter on screw threads, bolts, and fastenings; a rewritten and greatly enlarged chapter on working drawings, with sixty carefully graded problems; a new chapter on structural drawing; an extension of the scope of the chapter on architectural drawing; the addition of new problems in each chapter; and the addition of an appendix containing useful tables and diagrams. The book as enlarged is adapted for advanced courses in machine drawing, and the group arrangement provides an adequate series of problems for either long or short courses.

NEW CATALOGUES AND CIRCULARS

Foster Machine Co., Elkhart, Ind. Circular illustrating and describing the Foster No. 2-B universal turret lathe, its tools, and attachments.

Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill. Circular 27 of "Thor" pneumatic and electric tools, giving dimensions, capacities, etc.

Griscom-Russell Co., 90 West St., New York City. Bulletin 1110, containing a detailed description of the Stratton air separator for removing water from compressed air.

Canton Foundry & Machine Co., Canton, Ohio. Catalogue of portable floor cranes and hoists, giving the dimensions and capacities of the various sizes made by this company.

New Britain Machine Co., New Britain, Conn. Bulletin 1206-A, describing New Britain all-steel work-stands, provided with two or three trays and with or without drawers.

Foster Machine Co., Elkhart, Ind. Catalogue illustrating and describing H. & M. thread milling machines for brass parts, for steel parts, and for shrapnel and high-explosive shells.

Aluminum Castings Co., 6205 Carnegie Ave., Cleveland, Ohio. Circular entitled "Being an Account of a Little Talk with an Explorer," advertising "Lynux" and "Lynite" machined products.

Gisholt Machine Co., Madison, Wis. Circular illustrating the Gisholt universal tool grinder in use in a big plant. The circular lists the advantages to be obtained through the use of this machine.

Herman A. Holz, Metropolitan Tower, New York City. Circular descriptive of the magnet-meter, an apparatus for the precise, convenient, and rapid investigation of the magnetic qualities of permanent magnets.

Turner Machine Co., Danbury, Conn. Catalogue 15 of Quint's vertical-turret drilling, tapping, and chucking machines, giving dimensions and information on the construction and operation of these machines.

Community Machine & Tool Works, Inc., 122 Center St., New York City. Circular illustrating and describing the Community thread gage grinding machine, which, it is claimed, will grind gages within 0.0001 inch accuracy in the lead and five minutes in the angle.

Crescent Belt Fastener Co., 381 Fourth Ave., New York City, is issuing a chart showing how to most effectively join a given belt by the use of Crescent belt fasteners. The chart gives the number of the fastener to be used for different widths of belts, diameters of pulleys, and types of work. Copies will be sent to all interested.

E. C. Atkins & Co., Inc., Indianapolis, Ind. Catalogue descriptive of Atkins "Kwick-kut" metal-cutting machines. Catalogue of Atkins circular metal-cutting saws, containing tables of dimensions and prices. Hacksaw chart and price list, giving prices of hacksaw blades of different dimensions and specifying the work for which each is particularly adapted.

Austin Co., Cleveland, Ohio. Catalogue 5, descriptive of the Austin method of factory construction, a method of erecting permanent and substantial factory buildings in the minimum of time, by standardization and quantity production. Standardized designs and specifications are drawn up for various industrial types of construction, and materials for building, such as fabricated steel, steel sash, roofing, lumber, etc., are carried in stock, so that it is possible to deliver them to any job when they are needed, without delay.

Brown Portable Elevator Co., 10 S. La Salle St., Chicago, Ill. Bulletin 2, entitled "Cutting Costs by the Brown Portable Continuous-motion Handling Machines," showing how by means of these machines it is possible to release a large number of men required for handling, which is of particular interest at this time, when saving in man-power is of such importance. The catalogue illustrates many interesting applications of conveying machinery in all kinds of industries, and shows the difference in the cost of handling when done by hand and when done by machines.

Grand Rapids Grinding Machine Co., Grand Rapids, Mich. Catalogue entitled "The Grand Rapids Drill Grinder Book." The aim of the company in producing this book has been not only to portray the Grand Rapids line of drill grinding machines, but also to give definite information on what is needed in order to produce a properly ground twist drill. With this in view, chapters are included on "The Conditions Required for a Perfect Working Twist Drill—and Why," and "Helpful Hints Regarding the Care and Use of Twist Drills," illustrated with line drawings that make the principles very clear.

Scovill Mfg. Co., Waterbury, Conn. Annual accident report for 1917. The pamphlet contains photographs of the Scovill Mfg. Co.'s industrial hospital, and describes, in general, the sanitation and hygiene work done by the company, and the provision for the prevention and treatment of accidents. The report contains a classified list of the accidents during the years 1917, 1916, 1915, and 1914, from which it will be seen that a marked reduction has been made in the number of accidents. A table has also been included giving a comparative statement for 1916 and 1917 of the kinds of accidents, as well as a classification of the accidents by nationality and age.

Long & Allstatter Co., Hamilton, Ohio. Catalogue 21-A, illustrating and giving specifications for the complete line of punching and shearing machinery made by this company. The catalogue shows a large number of sizes and varieties of standard single and double machines, ranging in capacity from the smallest to the largest and most powerful types. The catalogue is indexed, making it convenient to refer to, and contains, in addition, tables of circumferences and areas, weights of flat rolled steel, U. S. standard gage for sheet and plate iron and steel, Birmingham wire gage, weight of one foot of round steel, weight of one foot of square steel, weight of flat steel in pounds per linear foot, and decimals of an inch and of a foot.

TRADE NOTES

Kelly Reamer Co., Cleveland, Ohio, has awarded a straight 10 per cent increase to all its employes.

Parker Mfg. Co., Ann Arbor, Mich., manufacturer of Parker drill chucks and arbors, at a recent board meeting elected Florence M. Huddy secretary of the company.

W. M. & C. F. Tucker, Hartford, Conn., makers of oil-hole covers and the "Hercules" line of shears and rod cutters, expect to occupy their newly acquired factory on Franklin Ave. some time this fall.

A. H. Alexander, United States representative of George H. Alexander, of Birmingham, England, specialist in complete mechanical equipments for manufacturing on the interchangeable plan, has moved from 44 Whitehall St., New York City, to 26 Cortlandt St.

Peninsular Tool Salvage Co., Detroit, Mich., has taken over half of the second floor of the building at 25 E. Fort St., Detroit, to be used as general offices and will establish a drill reclaiming department there. The company still maintains its factory at 45 E. Fort St.

U. S. Ball Bearing Mfg. Co., Chicago, Ill., has recently opened two new sales offices, one of which is located at 434 Rialto Bldg., San Francisco, Cal., and the other at 1437 Dime Bank Bldg., Detroit, Mich. S. C. Kyle is manager of the San Francisco office and A. deMaringh is manager of the Detroit office.

Continental Auto Parts Co., Knightstown, Ind., has recently increased its capital stock from $10,000 to $50,000, and is now making extensive additions to its plant and installing additional machinery and equipment in order to take care of the government contracts which it has on hand. This company manufactures a line of shop and factory equipment.

Cutler-Hammer Mfg. Co., Milwaukee, Wis., manufacturer of electric controlling devices and similar apparatus, has opened a branch office in the Union Trust Bldg., 15th and H Sts., N.W., Washington, D.C. H. W. Knowles and C. W. Yerger will be in charge of the new office. It will be operated entirely for the purpose of giving service to the Government and others having occasion to require information regarding the company's products, orders, contracts, etc.

Fay & Scott, Dexter, Me., have provided for the housing of their six hundred employes by constructing bungalows for the married men and a special building known as "Fayscott Inn" for the unmarried men. The entire project is under the supervision of Joseph Burnard, superintendent of the erection room. The Fayscott farm, also operated by Mr. Burnard, supplies a large part of the food for the employes, comprising eight acres of garden truck, and it has, in addition, a model dairy and piggery.

American Broach & Machine Co., which was organized July 1 and has been manufacturing broaches at 25 E. Fort St., Detroit, Mich., has been obliged to seek larger quarters, owing to the increasing volume of business which it is handling, and has moved to Ann Arbor, Mich., where the company occupies a new concrete building. The equipment has been increased considerably and the company is now able to make prompt deliveries. Francis J. Lapointe, formerly connected with the J. N. Lapointe Co., of New London, Conn., is president and general manager.

Walworth Mfg. Co., Boston, Mass., announces that it will discontinue the manufacture of the 6-inch "Genuine Walworth" stillson wrench in response to the request of the War Industries Board to manufacturers to release labor and conserve material and fuel. The company will also discontinue the manufacture of the wooden-handle "Genuine Walworth" stillson wrench in all sizes, continuing to make only the steel-handle wrench. These wrenches will have what is called "war finish" for the duration of the war. No change is to be made in the patterns or the quality of the material or workmanship, and the "war finish" wrench, although presenting a rougher appearance, will be of the same strength and quality as heretofore.

Brown & Sharpe Mfg. Co., Providence, R. I., announces that it has made arrangements for the sale in the state of New York and adjoining territories of Brown & Sharpe machinery and tools by a separate corporation entitled "Brown & Sharpe of New York, Inc." The new corporation is a subsidiary of the Brown & Sharpe Mfg. Co. Branch offices will be maintained at 20 Vesey St., New York City, 415 Chamber of Commerce Bldg., Rochester, N. Y., and 419 University Block, Syracuse, N. Y. Correspondence relating to prospective purchases should be addressed to Brown & Sharpe of New York, Inc., and sent to the nearest branch office. Remittances should be addressed to Brown & Sharpe of New York, Inc., and sent to Providence, R. I.

H. H. Franklin Mfg. Co., 738 Gifford St., Syracuse, N. Y., discontinued for the period of the war, over a month ago, the making of the Franklin automobiles, in order to be able to turn over its complete manufacturing facilities to war work. The company, which employs at present over three thousand people, expects to employ nearly double that number in war production within the near future. It is said to have been the first large motor car company in the country to have discontinued its automobile production during the period of the war. The officers of the company state that, in their belief, the curtailment of the automobile output will have no permanent effect on the automobile industry, and the automobile business will come back rapidly when the war is over. The Franklin Works will, however, continue to make the necessary repair parts for Franklin cars.

Whitman & Barnes Mfg. Co., Akron, Ohio, manufacturer of twist drills, reamers, wrenches, and forgings, has adopted a pension system for employes of the company which became operative September 1. All men employes who have reached the age of seventy years and all women employes who have reached the age of sixty-five years, and have been in the company's service continuously for fifteen years or more, shall be required to retire from service and shall be granted a pension. Men employes of sixty-five years and women employes of sixty years, who have been in the company's service continuously for twenty years or more, may, upon request, be retired from service and granted a pension. Men who have reached the age of sixty years and women who have reached the age of fifty-five years, and have been in the company's service continuously for twenty-five years or more, may, upon request, be retired from service and granted a pension. Any employe who has been in the company's service continuously for thirty years or more may, upon request, be retired from active service and be granted a pension. The pensions will be paid monthly as follows: For each year of continuous service, 1 per cent of the average regular monthly pay during the ten years preceding retirement. Pensions shall not exceed $100 per month, nor be less than $20 per month. These pensions will be granted to employes throughout their lifetime.